SCHOOL OF CIVIL ENGINEERING

INDIANA DEPARTMENT OF HIGHWAYS

JOINT HIGHWAY RESEARCH PROJECT
JHRP-89/1

ENGINEERING SOILS MAP OF FRANKLIN COUNTY, INDIANA
FINAL REPORT

Timothy H. DeWitt

PURDUE UNIVERSITY

Final Report

ENGINEERING SOILS MAP OF FRANKLIN COUNTY, INDIANA

by

Timothy H. DeWitt
Research Assistant

Joint Highway Research Project

Project No.: C-36-51-B

File No.: 1-5-2-83

Prepared as part of an Investigation

Conducted by

Joint Highway Research Project
Engineering Experiment Station
Purdue University

in cooperation with

Indiana Department of Highways
Indianapolis, Indiana

School of Civil Engineering
Purdue University
West Lafayette, Indiana

March 1, 1989

Final Report

ENGINEERING SOILS MAP OF FRANKLIN COUNTY, INDIANA

TO: H. L. Michael, Director
Joint Highway Research Project

March 1, 1989

Project: C-36-51B

FROM: Robert D. Miles, Research Engineer
Joint Highway Research Project

File: 1-5-2-83

The attached report entitled "Engineering Soils Map of Franklin County, Indiana," completes a portion of the long term project concerned with the development of county engineering soils maps of the 92 counties in the State of Indiana. This is the 83rd report of the series. The report was prepared by Timothy H. DeWitt, Research Assistant, Joint Highway Research Project under my direction.

The soils mapping of Franklin County was done primarily by the analysis of landforms as portrayed on stereoscopic aerial photographs. Information on soils was obtained from the Soil Conservation Service. Test data from roadway and bridge projects was obtained from IDOH. Generalized soil profiles for the landforms mapped are presented on the engineering soil map. A print of the engineering soils map of Franklin County in included at the end of the report.

Respectfully submitted,

Robert D. Miles

Robert D. Miles, P.E.
Research Engineer

RDM/rrp

cc: A.G. Altschaeffl
J.M. Bell
W.F. Chen
W.L. Dolch
R.L. Eskew
A.A. Fendrick
J.D. Fricker
D.W. Halpin
G.L. Henneky
R.A. Howden
M.K. Hunter
C.W. Letts
J.F. McLaughlin
K.M. Mellinger
R.D. Miles
P.L. Owens
B.K. Partridge
G.T. Satterly
C.F. Scholer
K.C. Sinha
C.A. Venable
T.D. White
L.E. Wood

ACKNOWLEDGMENTS

The author wishes to especially thank Professor Robert D. Miles, Professor in charge, for his advice, encouragement and guidance during the making of this project. Recognition also goes to Professor H. L. Michael, Director, Joint Highway Research Project, and the other members of the Joint Highway Research Board for their continued support of the engineering soil mapping project.

The author also wishes to thank his wife, Sheri, for her patience and her support. Acknowledgment also must go to the author's parents for their unending support during his academic career. Thanks also goes to Greg Johnson for his friendship and advice. Acknowledgment goes to the JHRP secretaries, Rita Pritchett and Cheryl Burroughs for their secretarial skills. And finally, special thanks to Weiging Xue for her excellent drafting of the soils map.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Engineering Soils Map of Franklin County, Indiana

Introduction

The engineering soils map of Franklin County was completed using primarily aerial photographic interpretation techniques. Aerial photographs were investigated stereoscopically by proven observational methods, in order to delineate land form parent material types [1]. The aerial photographs used in this project were taken for the U.S. Department of Agriculture in 1940. These photos were purchased from the U.S.D.A. and were printed at an approximate scale of 1:20,000 (3 inches = 1 mile). The engineering soils map attached was prepared at a scale ratio of 1:63,360 (1 inch = 1 mile).

The soil boundaries were cross-referenced with the Agricultural Soil Survey of Franklin County, Indiana [2, 3]. The engineering soil map includes landform - parent material associations and surface soil textural symbols. Locations of major road routes, lakes, gravel pits, rock quarries and borehole data are also included on the map. All symbols on the map are standardized symbols developed by the staff of the Airphoto Interpretation Laboratory, School of Civil Engineering, Purdue University, for mapping of engineering soils. Shallow soil profiles shown on the attached map represent soil horizons on the different parent material types. The profiles were developed using data collected from borehole records, agricultural soil characterization data, and soil records from nearby Decatur County. The text of this report contains a general description of the area, a description of the soil and parent material types, and a discussion of possible engineering problems associated with the soil and bedrock of the county.

DESCRIPTION OF THE AREA

GENERAL

Franklin County is located in southeastern Indiana, approximately 65 miles southeast of Indianapolis. Franklin County is bounded by Fayette and Union Counties on the north, Rush and Decatur Counties on the west, Ripley and Dearborn Counties on the south, and by Butler and Hamilton Counties of the state of Ohio on the east side (See Figure 1). Franklin County has dimensions of 15 to 17.5 miles in the north-south direction and 26 miles in the east-west direction. The maximum north-south dimension is on the western side of the county. Franklin County covers 395 square miles or 252,800 acres. Brookville, the county seat and largest city, is located in the central section of the county.

Franklin County was founded in 1811 before Indiana became a state. The county was named after Benjamin Franklin. Settlement of the area developed shortly after the Treaty of Greenville in 1795, when the local Indian tribes gave up claim to the area.

Population trends for Franklin County from the 1970 and 1980

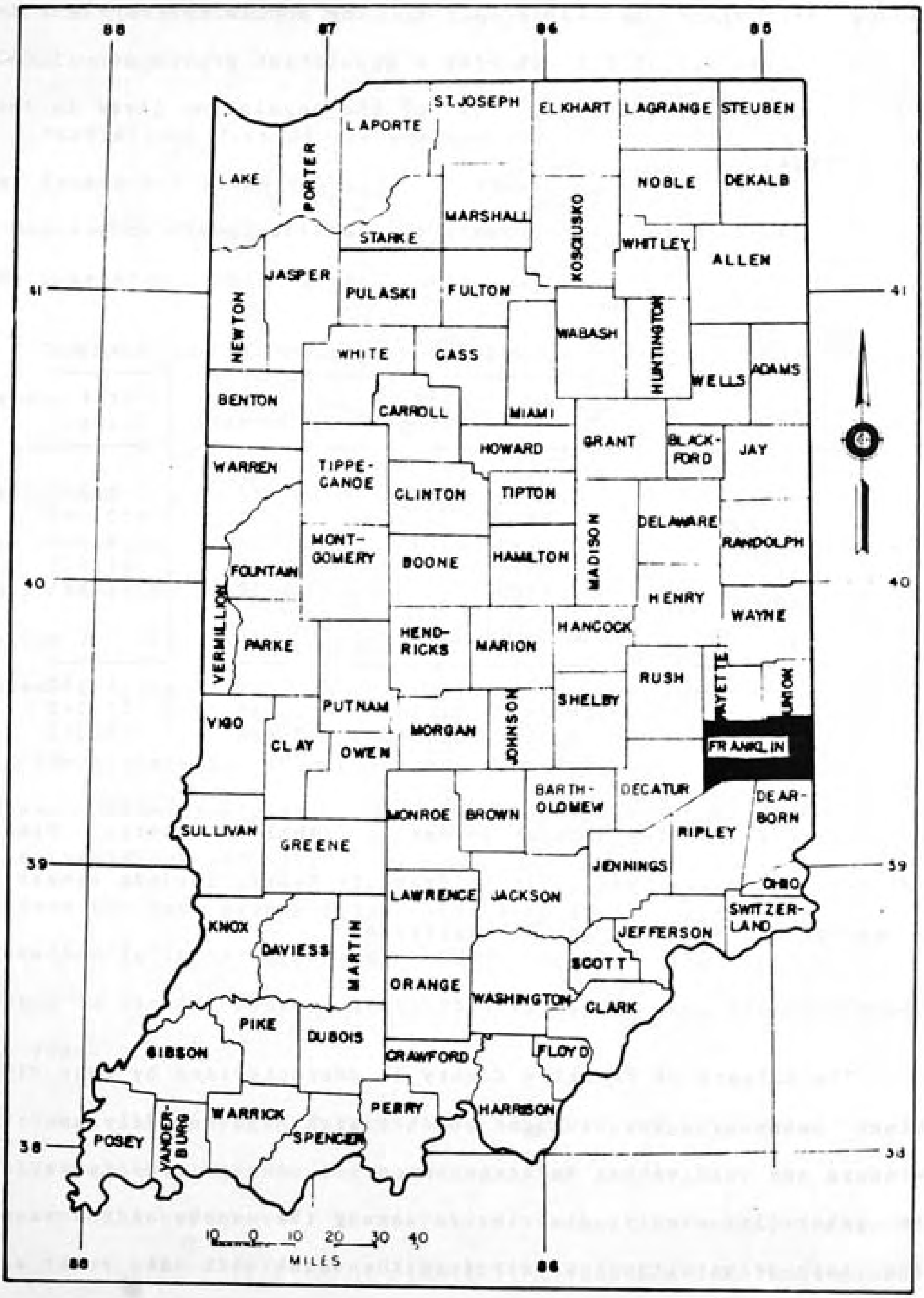


Figure 1. Location Map of Franklin County.

census are given in Table 1 [4]. The population of Franklin county in 1980 was 19,612, showing a population growth of 15.74% since 1970. Approximately 75% of the population lives in the rural areas.

Table 1. Population Summary of Franklin County [4].

	Population		Population Change	
City	1980 Census	1970 Census	Pop. Difference	Pct. Change
Brookville	2,874	2,864	10	0.35%
Cedar Grove	217	248	-31	-12.50%
Laurel	819	753	66	8.76%
Mt. Carmel	151	128	23	17.97%
Oldenburg	770	758	12	1.58%
Totals				
Cities and Towns	4,831	4,751	80	1.69%
Rural Areas	14,781	12,192	2,589	21.24%
County Total	19,612	16,943	2,669	15.75%

Farming provides a major income in Franklin County. Other natural resources available in Franklin County include mineable limestone and sand and gravel aggregate.

CLIMATE

The climate of Franklin County is characterized by four distinct seasons. The summers are hot with high humidity and the winters are cold with a moderate amount of snow. Precipitation is generally evenly distributed among the months of the year. The clash of warm tropical air from the south with cold polar air from the north produces frequent temperature and humidity changes in the county.

Statistical data of temperature and precipitation for Franklin County are given in Table 2. These statistics were recorded at Brookville, Indiana between the years of 1934-1963 [5]. A more complete climatological summary may be found in Appendix A.

The average daily temperature in Franklin County is 52.4 degrees F. The warmest month of the year is generally July, with an average daily temperature of 74.4 degrees F. Approximately thirty-four days of the year will experience a maximum temperature exceeding 90 degrees F. January is, generally, the coldest month of the year with an average daily temperature of 30.0 degrees F. The maximum daily temperature will not reach 32 degrees F approximately twenty-two days a year.

The average yearly precipitation in Franklin County is 38.49 inches. This precipitation comes in the form of rain, snow, and sleet throughout the year. The month of May, on the average, receives the most precipitation with 4.19 inches. The least precipitation falls in October with 2.35 inches. Franklin County expects to receive approximately 15.3 inches of snow accumulation each year.

Winds in Franklin County blow most frequently from the southwest. During one or two months of the winter, the winds blow from the northwest. Thunderstorms occur on about forty-eight days of the year, usually in the spring and early summer [5].

Table 2. Climate Summary for Franklin County (5).

LATITUDE 39° 25' N.
LONGITUDE 85° 01' W.
ELEV. (GROUND) 600 Ft.

STATION BROOKVILLE, INDIANA

MEANS AND EXTREMES FOR PERIOD 1934-1963

Month	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Mean degree days **	Precipitation Totals (Inches): Mean	Greatest daily	Year	Snow, Sleet: Mean	Maximum monthly	Year	Greatest daily	Year	Mean number of days: Precip. .10 inch or more	Temperatures Max.: 90° and above	32° and below	Min.: 32° and below	0° and below	Month
(a)	30	30	30	30		30		30	30	30		30	30		30		9	30	30	30	30	
Jan.	39.7	20.3	30.0	79	1943	-25	1963	1042	3.29	3.08	1949	4.0	11.2	1929	10.0	1951	4	0	7	27	2	Jan.
Feb.	42.4	21.0	32.4	72	1961+	-22	1951	902	2.59	1.76	1945	3.0	12.0	1961	6.0	1951	6	0	5	24	2	Feb.
Mar.	52.2	28.9	40.6	83	1948+	-6	1943	766	3.65	2.98	1943	3.1	12.0	1959	7.0	1959	7	0	2	21	*	Mar.
Apr.	64.0	38.3	51.2	89	1948+	18	1940	405	3.43	2.67	1957	T	1.0	1956+	1.0	1956+	7	0	0	9	0	Apr.
May	74.9	48.1	61.5	95	1934	26	1963	161	4.19	4.03	1961	T	T	1954	T	1954	8	1	0	1	0	May
June	83.6	58.1	70.9	104	1944	37	1954	33	4.01	2.53	1947	0	0		0		7	7	0	0	0	June
July	87.3	61.4	74.4	108	1936	45	1947+	6	3.73	3.35	1953	0	0		0		9	11	0	0	0	July
Aug.	86.5	60.1	73.3	105	1936	40	1934	0	2.73	3.34	1960	0	0		0		5	10	0	0	0	Aug.
Sept.	81.1	51.7	66.4	104	1951	25	1942	84	3.23	4.58	1936	0	0		0		5	5	0	1	0	Sept.
Oct.	70.1	40.1	55.0	92	1951	15	1952	329	2.35	2.68	1937	T	0.4	1959	0.4	1959	6	*	0	7	0	Oct.
Nov.	52.0	30.8	41.4	86	1950	-7	1958	678	2.79	3.15	1938	1.6	9.0	1958	7.5	1958	6	0	1	18	*	Nov.
Dec.	42.0	21.5	31.8	71	1956	-16	1960	1004	2.50	2.05	1945	3.6	14.3	1942	6.6	1943	4	0	7	26	2	Dec.
Year	64.4	40.4	52.4	108	July 1936	-25	Jan. 1963	5410	38.49	4.58	Sept. 1936	15.3	14.3	Dec. 1942	10.0	Jan. 1951	74	34	22	134	6	Year

(a) Average length of record, years.

T Trace, an amount too small to measure.

** Base 65°F

\+ Also on earlier dates, months, or years.

* Less than one half.

DRAINAGE FEATURES

Figure 2 is the "Drainage Map of Franklin County, Indiana" prepared in 1947 by the Joint Highway Research Project at Purdue University [6]. Franklin County is drained by portions of two watersheds of Indiana as illustrated in Figure 3 [7]. These are the Whitewater River watershed and the Minor Ohio watershed.

The Whitewater River watershed drains in excess of 90 percent of Franklin County. This area includes all of the county except for the southwest corner and a small section on the eastern side. The general trend of the drainage from the Whitewater watershed is towards the southeast. In Franklin County, the Whitewater River watershed has two major sections. These are the West and East forks.

The West Fork Whitewater River enters Franklin County on the north side approximately 6.5 miles east of the western boundary near Laurel [8]. After flowing south for about five miles, it turns eastward and joins the East Fork Whitewater River about one-half mile south of Brookville. The Whitewater River then flows southeast and leaves the county approximately 4.5 miles west of south eastern corner of the county.

West Fork Whitewater River has several major tributaries in Franklin County. Sein Creek flows southeast, draining a portion of north-central section of the county before joining West Fork,

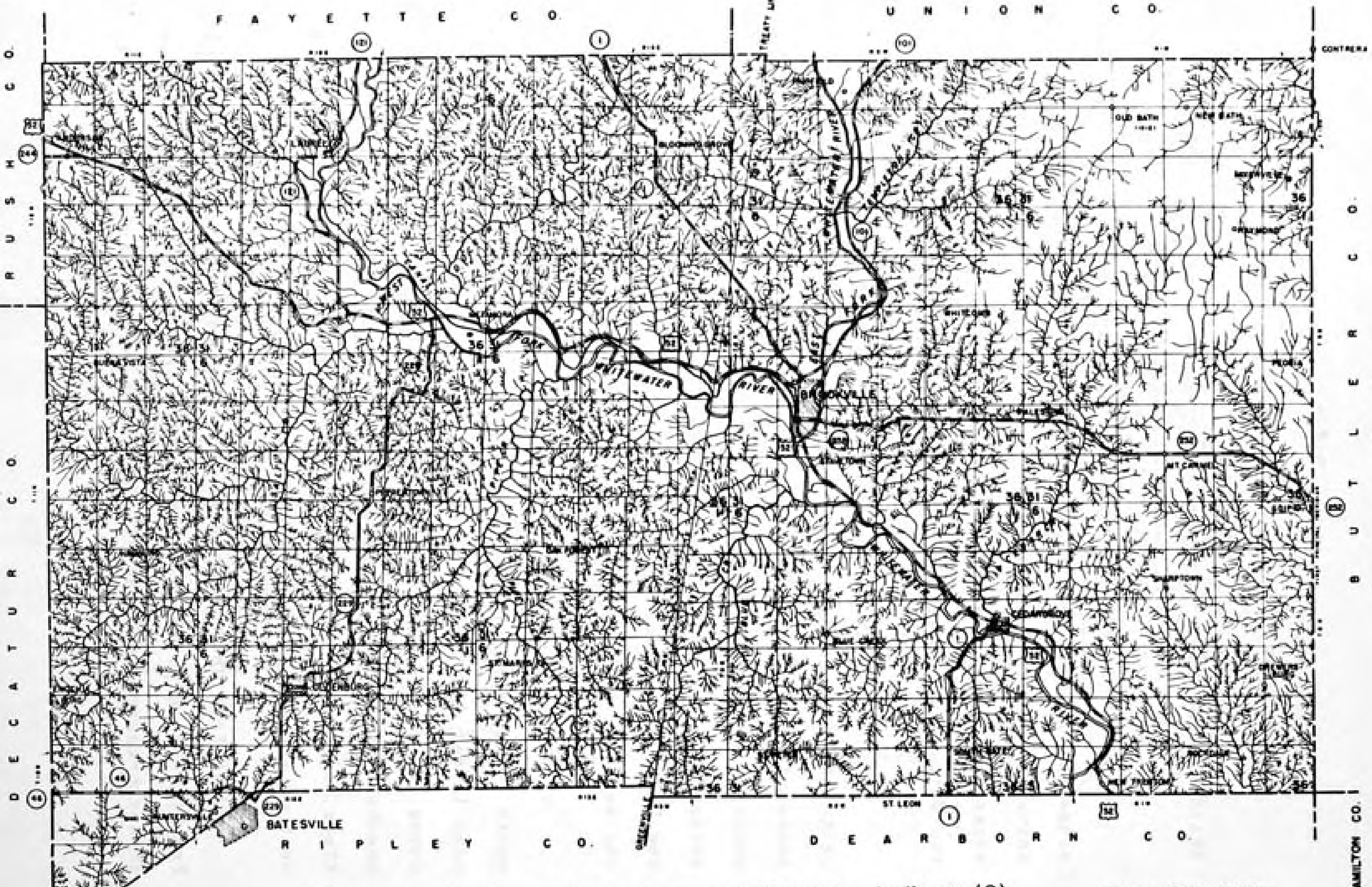


Figure 2. Drainage Map of Franklin County, Indiana (6).

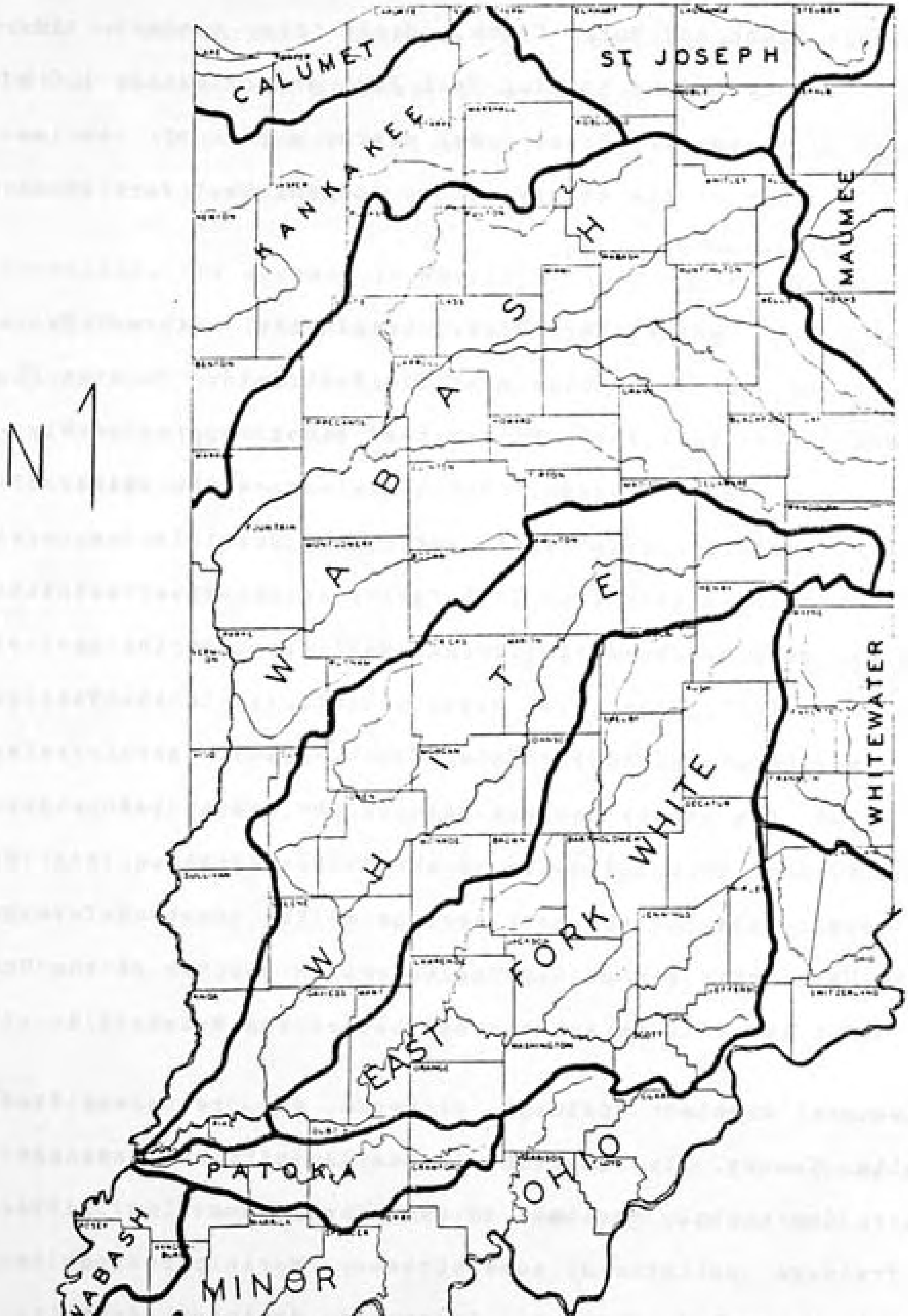


Figure 3. Watersheds of Indiana (7).

0.5 miles south of Metamora. Salt Creek and its tributaries, Little Salt Creek and Bull Creek, drain the western side of Franklin County before joining West Fork approximately 1.0 miles southwest of Metamora. Piper Creek drains a part of the south-central section of the county before joining West Fork about 1.5 miles southeast of Metamora.

East Fork Whitewater River originally entered Franklin County north of Brookville near Old Fairfield. It then flowed south and joined West Fork Whitewater River approximately 0.5 miles south of Brookville. But a dam across the valley of the East Fork approximately one mile north of Brookville has created the Brookville Reservoir. Tributaries to the reservoir include Templeton Creek on the east side and Wolf Creek on the west side. Below Brookville, the two major tributaries to the Whitewater River are Blue Creek and Big Cedar Creek. Blue Creek drains a section of the south-central part of the county before joining the Whitewater River 1.5 miles south of Brookville. Big Cedar Creek drains part of the east section of the county before joining the Whitewater River at Cedar Grove. A section of the Whitewater Canal is still intact between Laurel and Brookville.

Several distinct drainage patterns may be identified in Franklin County. In areas of Wisconsinan till the drainage pattern are dendritic. Moraines in the county have also influenced the drainage patterns of some streams. Moranic control is seen by local watershed divides, increased drainage density, and deflection of streams in these areas [6]. Drainage patterns in

Illinoian till areas are characterized by a very highly dissected dendritic or sub-parallel pattern [8]. Terraces along the Whitewater River system lack drainage lines due to the highly permeable nature of the underlying granular materials. Most streams are underfit to their valleys.

Generally, the streams in Franklin County have narrow floodplains with widths less than 300 feet. The valley of the Whitewater River and its two forks will average more than a mile in width. Rock cropouts may be found in the valley walls or close to the surface of almost all of the streams in Franklin County. This is especially true along the Whitewater River and its tributaries (refer to the engineering soils map). In upland streams, next to main streams, limestones and shales have produced a minutely dendritic pattern to rectangular pattern [8]. Flowing over alternating resistant and non-resistant rock also may cause minor stream deflection. The deflection of the West Fork Whitewater River towards the southeast is probably due to the Laughrey Escarpment. However, deflections of major tributaries close to junctions with major rivers also may be partially due to the presence of granular terraces [6].

There are no natural lakes in Franklin County. However, scattered ponds and artificial lakes do exist throughout the county including Brookville Reservoir (see engineering soils map for locations).

Table 3 contains drainage densities for selected streams in

Table 3. Drainage Densities for Selected Streams in Franklin County (9).

Stream and Location	Quad.	Sec.	Twn.	Rng.	Drainage Area (mi^2)	Drainage Density ($Streams/mi^2$)
Bull Fork at Mouth	Metamora	17	11N	12E	47.6	8.0
Big Cedar Creek at Mouth	Cedar Grove	13	8N	2W	21.5	8.8
Big Cedar Creek above Tributary	Mt. Carmel	29	9N	1W	7.72	5.7
Big Cedar Creek Tributary at Mouth	Mt. Carmel	29	9N	1W	7.11	4.7
Duck Creek at Mouth	Brookville	31	12N	13E	25.8	9.1
Harvey Branch at Mouth	Metamora	20	11N	12E	8.90	8.6
Little Cedar Creek at Mouth	Mt. Carmel	3	8N	2W	10.5	8.5
Salt Creek above Bull Fork	Metamora	17	11N	12E	57.6	8.0
South Fork Little Salt Creek at Mouth	Metamora	31	12N	12E	11.8	5.4
Wolf Creek at Mouth	Brookville	32	9N	2W	6.26	8.0

the county. The table includes the area drained in square miles and also the number of streams per square mile [9].

Appendix B contains statistical streamflow data for the Whitewater River (at Brookville, Franklin County and near Alpine, Fayette County) and for East Fork Whitewater River (at Brookville, Franklin County). The data includes information on lowest and highest mean discharge, average daily discharge, flow duration, and statistics on normal and log monthly, log annual means, and peak annual discharge [10].

Appendix C contains low flow characteristics for streams which drain Franklin County. The streams include Whitewater River (at Brookville, Franklin County and at Alpine, Fayette County), East Fork Whitewater River (at Brookville, Franklin County), and Salt Creek (near Metamora, Franklin County) [11].

PHYSIOGRAPHY

Franklin County is located in the Dearborn Upland physiographic province of Indiana. In relation to the physiographic provinces of the United States, it is in the Till Plains section of the Central Lowland province [12].

The Dearborn Upland is a low dissected plateau of Late Ordovician limestones and shales that outcrop along the crest of the Cincinnati Arch. The rocks are overlain by generally less than 50 feet of glacial drift. The Dearborn Upland within Franklin County contain part of the Laughrey Escarpment. This is found on the Western side of the county and provides a natural drainage divide. To the West of this is found Silurian age limestones and interbedded shales [13].

The glaciers buried most of the bedrock surfaces; therefore, both the Illinoian Till Plain and the Wisconsinan Till Plain form the physiographic units of the glacial plain. Figure 4 is a map of Indiana showing physiographic units and glacial boundaries [12]. Figure 5 is a generalized bedrock geology map of Indiana [14].

TOPOGRAPHY

Franklin County has a surface expression of a highly dissected glacial plain. Thus, the topography of Franklin County can be characterized as ranging from gently undulating to rugged valley form. Near Blooming Grove is the maximum elevation in the county, standing at 1040 feet above sea level. The minimum elevation of 525 feet above sea level occurs in the southeastern corner of the county, where the Whitewater River exits the county. Other elevations at different points in the county include: Brookville, 630 feet above sea level; Peoria, 999 feet above sea level; Raymond, 1,008 feet above sea level; and Bath, 1012 feet above sea level [2]. The maximum relief difference is 515 feet. However, maximum local relief is approximately 300 feet. This is found in the valley of the Whitewater River where the difference between the valley floor and the ridge crests show an entrenchment of 300 feet near the central sections of the

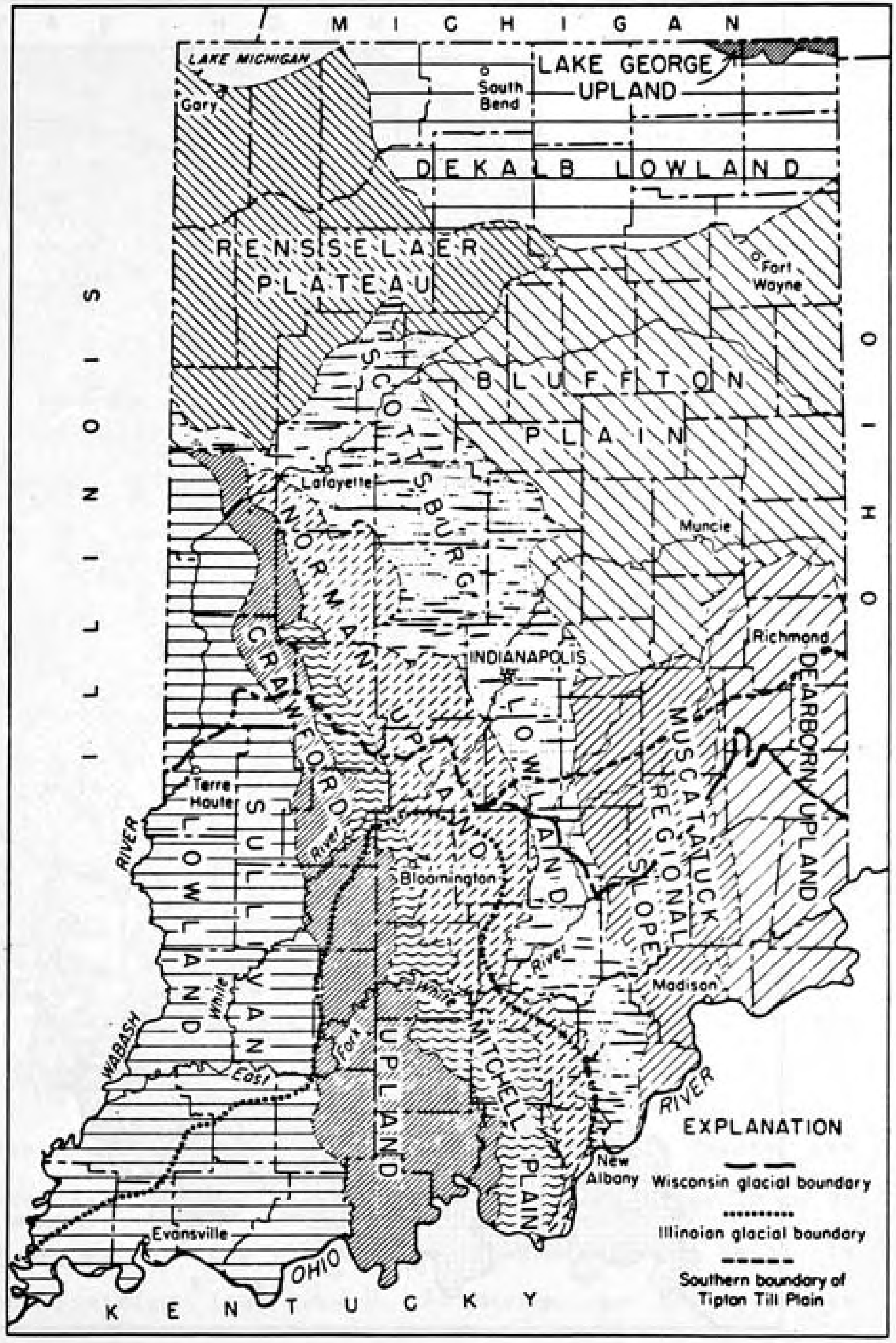


Figure 4. Physiographic Units of Indiana (12).

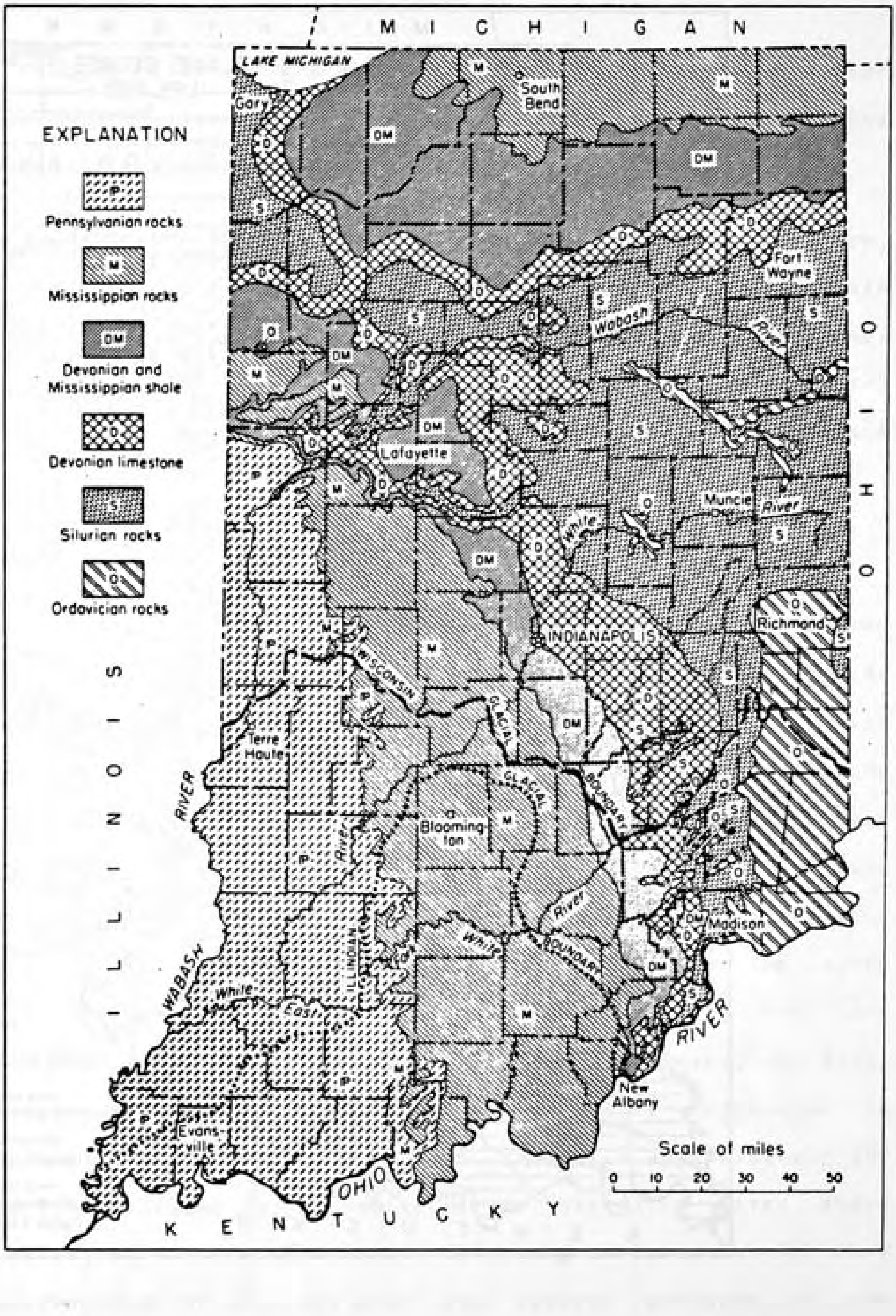


Figure 5. Bedrock Geology Map of Indiana (14).

county [2]. Figure 6 is a topographic map of Franklin County based on 100 foot contour intervals [15].

The Illinoian drift sections of the county are characterized as nearly flat. The Illinoian is the oldest exposed glacial deposits within Franklin County. Thus, these deposits are severely weathered. At one time, the Illinoian surface expression was probably very much like the Wisconsinan, gently rolling. Over time, the erosion process has leveled the Illinoian deposits off to a flat surface as seen today. For these reasons, the Illinoian posesses a heavily dissected, flat topographic expression.

The Wisconsinan ground moraine sections of the county have a topography that is gently undulating to rolling. The Wisconsinan sections are young. Thus time and erosional processes have not had the time to level off its surface like the Illinoian has been leveled off. Local elevation differences upon the ground moraine are between 5 to 20 feet. Stream dissection is not as intense as in the Illinoian. Stream entrenchment may still reach 40 feet below the ground moraine surface. Both the Wisconsinan and the Illinoian ground moraines may be found at the summit of the bluffs close to the Whitewater River.

Wisconsinan ridge moraine topography in Franklin County can be characterized as rolling. The ridge moraine rises 20 to 30 feet above the surrounding plain. The ridge moraine helps to define the dividing line between the Wisconsinan and Illinoian ground moraines.

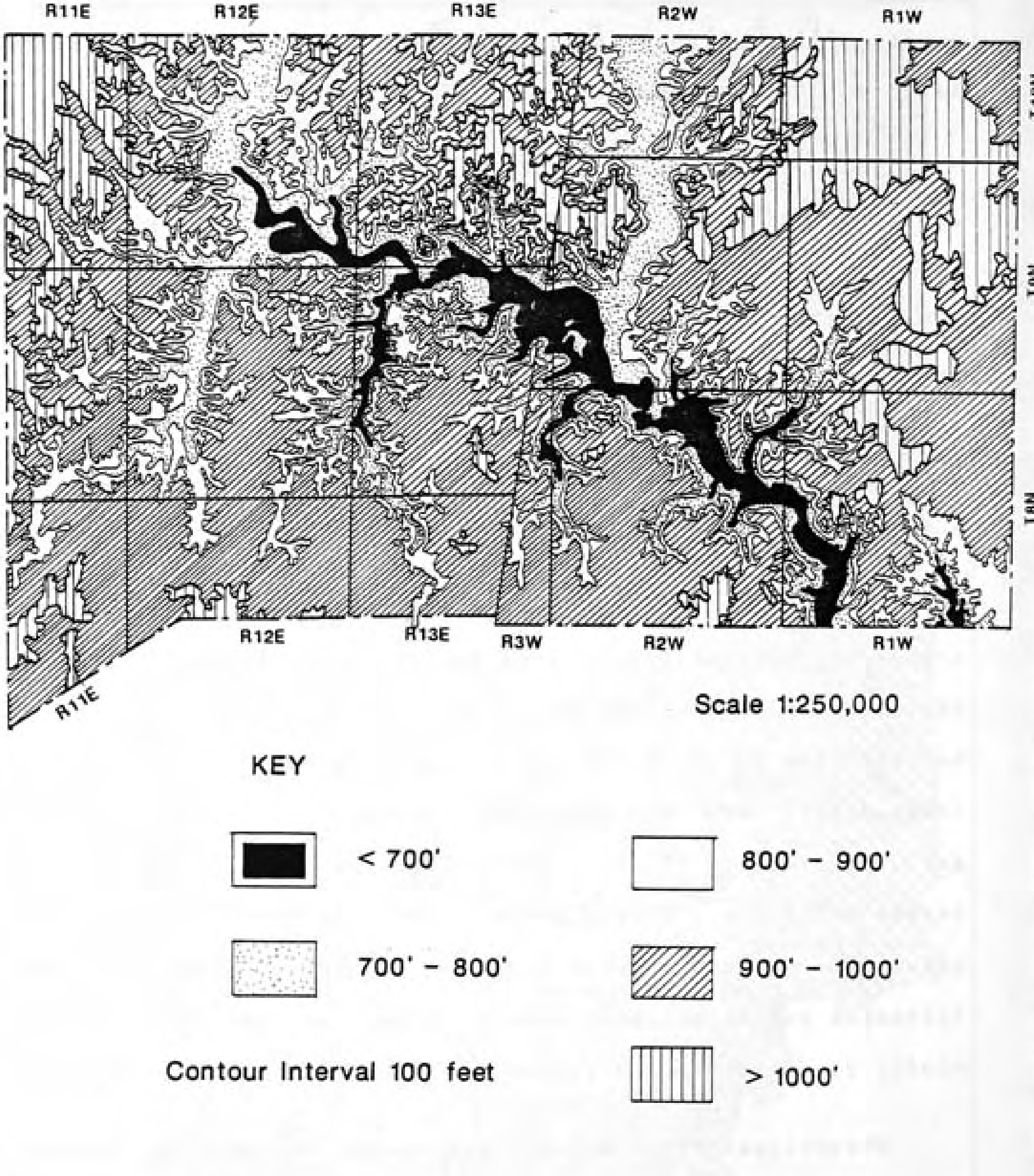


Figure 6. Topographic Map of Franklin County (15).

There are other interesting topographic features in Franklin County. The Whitewater River valley cuts, in places, about 300 feet below the surrounding glacial plains and cuts the county in half. The outwash terraces of the Whitewater valley forms a series of flat "steps" along the valley walls. There is about a 50 to 60 foot difference in elevation between the highest and lowest of these terraces. Sand dunes in the county cap ridges and terraces in scattered locations. And finally, interbedded limestones and shales underlie various sections of the county at shallow depths influencing geomorphology and topography.

STRUCTURAL GEOLOGY

Franklin County lies on the western limb of a geologic structural feature known as the Cincinnati Arch. The Cincinnati Arch is a large anticline of slightly dipping rocks. The rock systems represented in the Cincinnati Arch include, by increasing age, the Pennsylvannian, the Mississippian, the Devonian, the Silurian, and the Ordovician systems. Franklin County contains rocks of the Silurian and the Ordovician systems. The dip of the rocks which belong to these two systems in Franklin County is approximately 10-15 feet per mile in a west-southwesterly direction. Figure 7 is a map showing the relationship and location of Franklin County in reference to the structural geology of the Midwest.

BEDROCK GEOLOGY

Franklin County contains rock units from portion of two rock

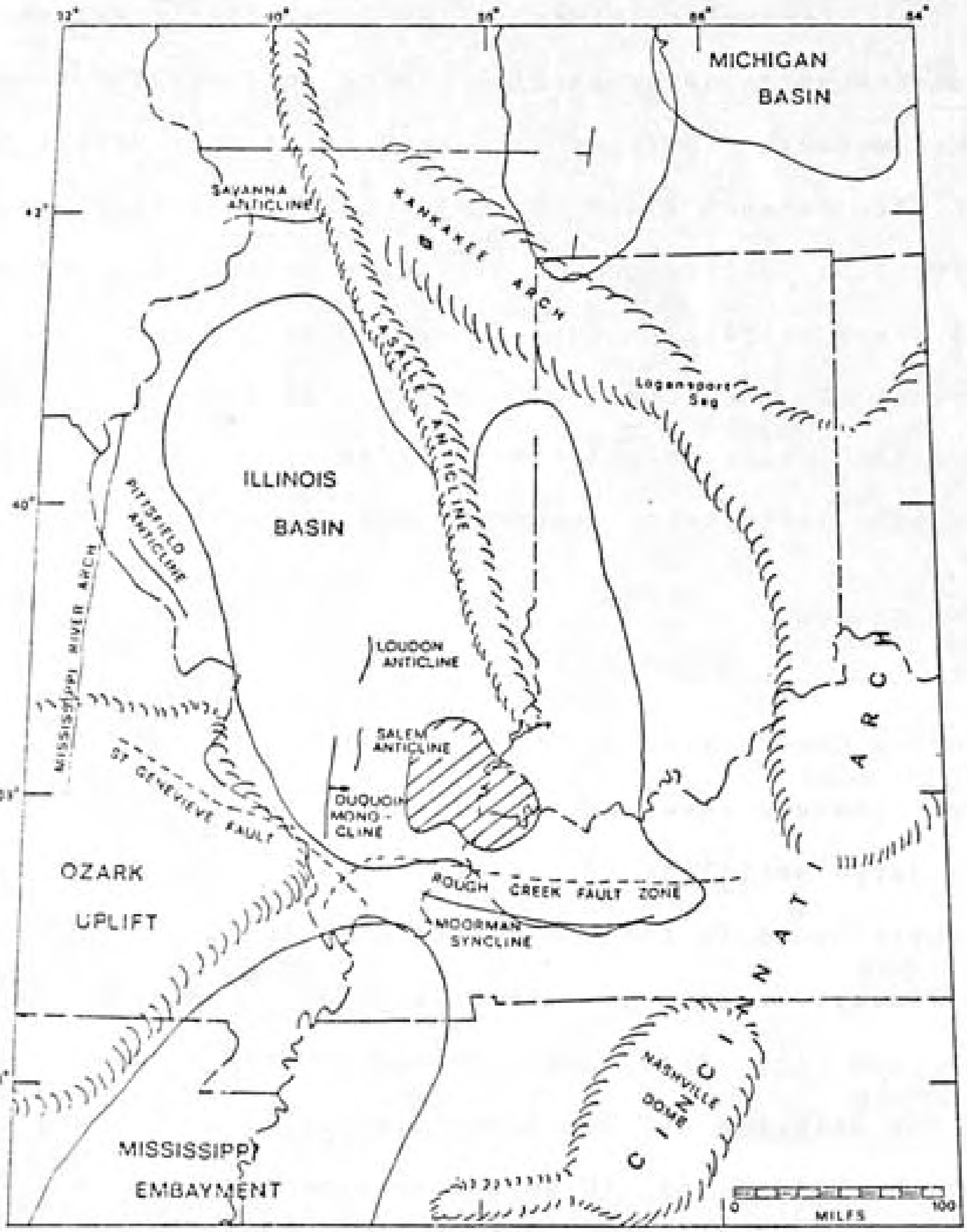


Figure 7. Structural Setting of Indiana.

systems [16]. These rock systems are the Silurian and the Ordovician. Erosion of preglacial valleys has allowed interfingering of the rock units, which would normally lie in north-south bands within the county.

Table 4 is a stratigraphic column for Franklin County. The column shows bedrock units and glacial deposits which underlie or are encountered in Franklin County. Anticipated thickness and a characteristic description is given for each rock unit [17]. Figure 8 is a map of the bedrock geology of Franklin County representing the areal extent of the Silurian and the Ordovician groups and units in the county [18].

The Silurian system in Franklin County contains three units. These are the Waldron Shale, the Salamonie Dolomite, and the Brassfield Limestone. All of the units of the Silurian system are found on the western edge of the county (refer to Figure 9). The Waldron Shale is characterized as a thinly bedded, very fossiliferious, easily eroded shale ranging in thickness from zero to six feet. Below the Waldron Shale is the Salamonie Dolomite with its two members, the Laurel Member and the Osgood Member. The total thickness of the Salamonie Dolomite is between zero to 90 feet [17]. The Laurel Member is characterized as a dolomitic limestone, which is thickly bedded, very argillaceous, and contains abundant chert. The Osgood Member is a highly agrillaceous dolomite or limestone having an increasing shale content as you move southward. The older Silurian units, the Osgood Member and

Table 4. Stratigraphic Column for Franklin County (17).

AGE	FORMATION NAME		APPROXIMATE THICKNESS	GENERAL DESCRIPTION
SILURIAN	Waldron Shale		0-6'	Shale, blue-gray and clayey, thin-bedded; very fossiliferous and easily eroded.
	Laurel Member	Salamonie Dolomite	0-90'	Dolomitic limestone, light-gray to tan; fine-grained and argillaceous; thick bedded with abundant chert.
	Osgood Member			Dolomite or Limestone, tan to tan-gray, highly argillaceous; shale content increases southward.
	Brassfield Limestone		0-10'	Limestone, variable white,yellow-brown to salmon-pink, medium- to coarse-textured, and fossiliferous ; some dolomite and irregular shale lenses.
ORDOVICIAN	Whitewater Formation		0-60'	Interbedded calcareous Shale and Limestone, light- to dark-gray; thin-bedded.
	Dillsboro Formation		~300'	Argillaceous Limestone and calcareous Shale; thin; inter-bedded, highly fossiliferous, containing about 70% shale.
	Kope Formation		>200'	Interbedded Limestone and calcareous Shale, thin-bedded, fossiliferous.

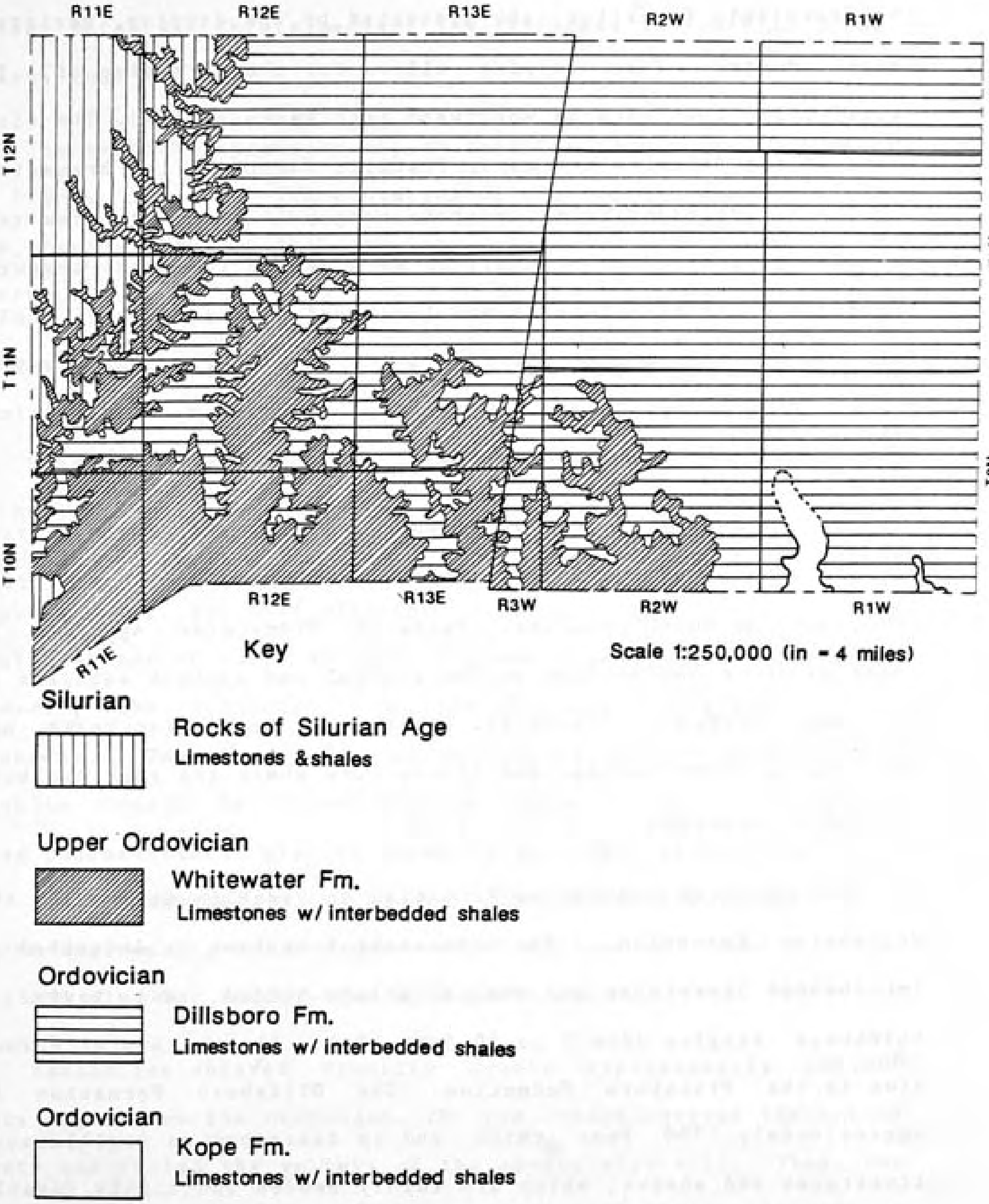


Figure 8. Bedrock Geology Map of Franklin County (18).

the Brassfield formation, are protected by the capping, resistant Laurel Member. This capping allows for the formation of a low relief plain that extends southward into Kentucky [17]. The final unit of the Silurian system in Franklin County is the Brassfield Limestone. The Brassfield Limestone ranges in thickness from zero to 10 feet. It is characterized as a medium to coarse-textured limestone containing fossils and lenses of dolomite and shale. The total thickness of Silurian units in Franklin County may be as much as 110 feet thick. However, due to erosion, actual thickness is expected to be much less.

The Ordovician system in Franklin is composed of three formations. These are the Whitewater Formation, the Dillsboro Formation, and the Kope Formation. Rocks of Ordovician Age may be found close to the surface in the central and eastern sections of the county (refer to Figure 8). Outcrops of Ordovician rocks may be found in river valleys and stream cuts where the rock has been exposed by erosion.

The youngest Ordovician formation in Franklin County is the Whitewater Formation. The Whitewater Formation is described as interbedded limestones and shales, thinly bedded, and having a thickness ranging from 0 to 60 feet. Below the Whitewater Formation is the Dillsboro Formation. The Dillsboro Formation is approximately 300 feet thick and is described as argillaceous limestones and shales, which are thinly bedded and highly fossiliferous. The final Ordovician formation is the Kope Formation. The Kope Formation is described as interbedded limestones and shales, which are thinly bedded. Its thickness in Franklin County is less than 300 feet.

The bedrock topography map of Franklin County is presented in Figure 9 [19]. The elevation of the bedrock surface ranges from greater than 900 feet to less than 500 feet within the county.

GLACIAL GEOLOGY

Glacial activity has had a great effect upon the development of the soils in Franklin County. Approximately 80 percent of the county is covered by glacial or glacially-derived deposits. Franklin County has been affected by three of the four recognized glacial stages of North America. These three are the Kansan (oldest), the Illinoian, and the Wisconsinan glacial stages (youngest). The distribution of the unconsolidated deposits in Franklin County is illustrated in Figure 10 [18]. This figure shows unconsolidated glacial deposits and also younger alluvial and eolian deposits in the county. The reader should also refer to the engineering soils map for distributions of glacial deposits and also for anticipated soil profiles.

Kansan ice entered Franklin County approximately 400,000 years ago from the northeast. The ice sheets covered the entire county and filled the valleys of the county with till. Thus, the entire area was incorporated into a vast till plain. Deposits of the Kansan glacial stage are known as the Jessup Formation of

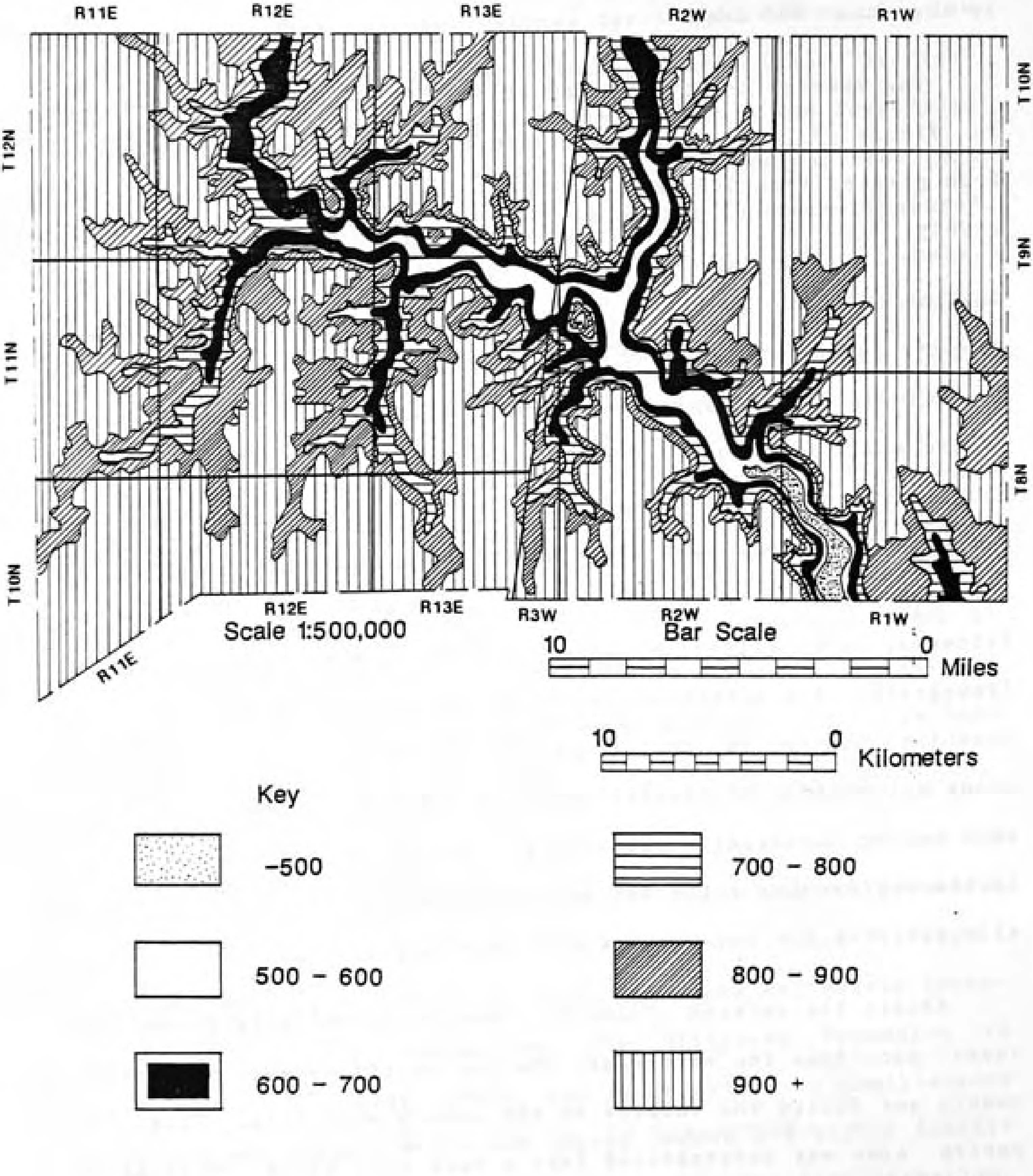


Figure 9. Bedrock Topography Map of Franklin County. (19)

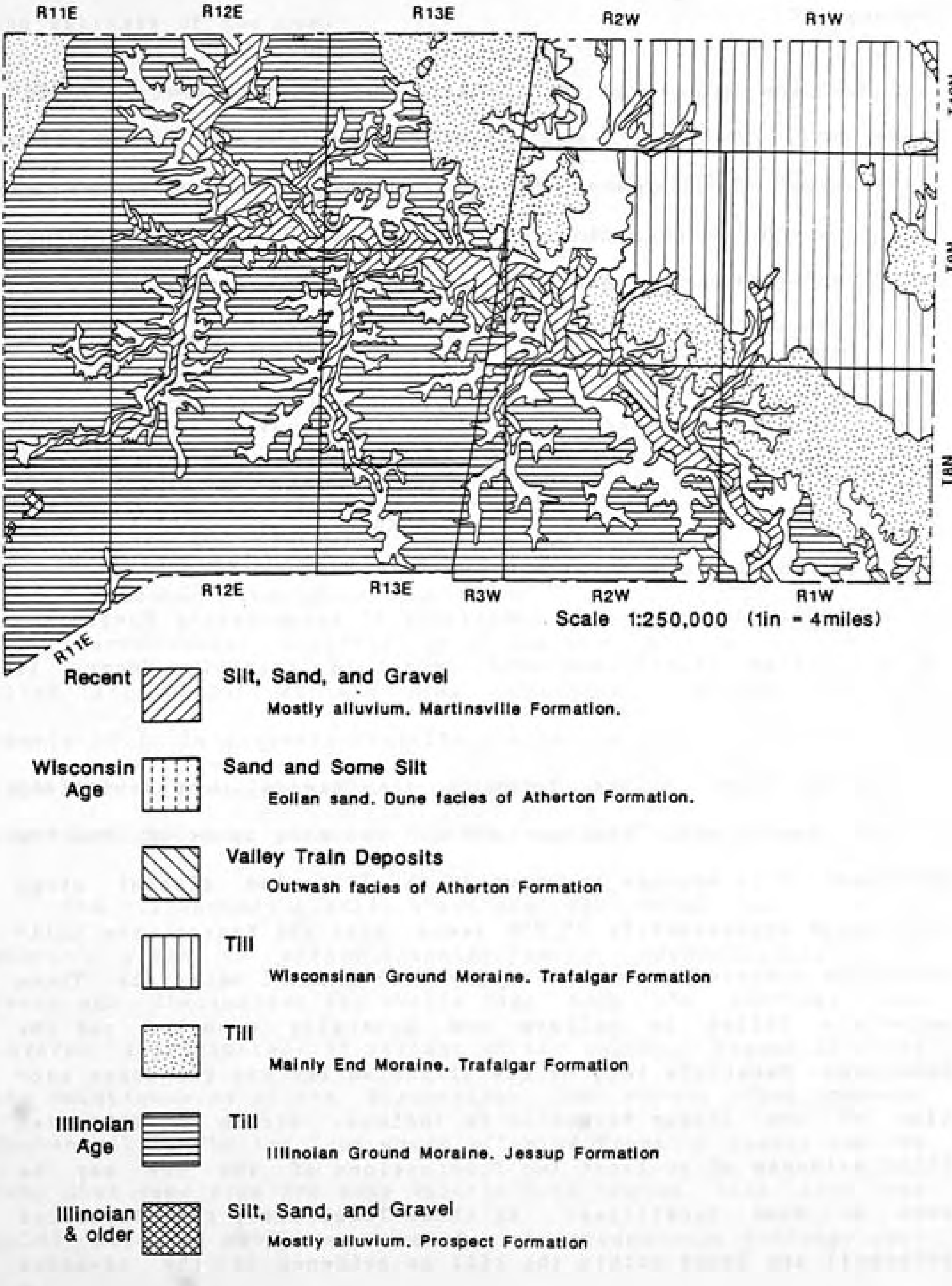


Figure 10. Unconsolidated Deposits Map of Franklin County (18).

Indiana [20].

Upon the retreat of the Kansan ice approximately 200,000 years ago, the county experienced an interglacial period which lasted about 75,000 years. This interglacial period was known as the Yarmouth interglacial. The period was marked by an intense period of erosion during which, generally, all of the Kansan deposits were eroded away. There is a possibility that in some locations, borings may show the presence of a pre-Illinoian paleosoil [17]. In addition, the deeply buried valley of the Whitewater River, which is pre-Kansan in age, probably contains Kansan-age deposits. The average thickness of Kansan deposits in this section of the Midwest are on the order of fifteen feet thick [20]. But today, the likelyhood of encountering Kansan-age deposits of any significant areal extent in Franklin County is slight.

At the close of the Yarmouth interglacial, approximately 125,000 years ago, another glacial advance occurred from the northeast. This advance is known as the Illinoian glacial stage and lasted approximately 25,000 years. Like the Kansan, the Illinoian ice covered the entire county with glacial materials. These materials filled in valleys and generally smoothed out the landscape. Materials left by the Illinoian ice are the upper section of the Jessup Formation in Indiana. Within the Illinoian till, evidence of at least two fluctuations of the ice may be seen at some localities. At these localities, thin layers of paleosoil are found within the till as evidence of the advances and retreats of the ice.

The Illinoian ice withdrew about 100,000 years ago giving way to the Sangamon interglacial. Like the Yarmouth, the Sangamon was a time of intense erosion and weathering of the young, unconsolidated Illinoian drift. The paleosol developed during this interglacial period ranges in thickness from two to four feet.

Today, the Illinoian can be observed as a surface parent material in the western and central section of Franklin County. The rest of the Illinoian materials deposited in Franklin County have been covered by the younger Wisconsinan materials and more recent alluvial materials. The total thickness of the Illinoian and pre-Illinoian deposits is on the average less than 25 feet thick [17]. Figure 11 is a drift thickness map for Franklin County [21]. In general, Franklin County has a drift thickness of less than 50 feet, except in some areas were the total thickness may reach 150 feet (i.e. in the Whitewater River valley).

The Wisconsinan glacial stage was the final and youngest glacial stage to affect Franklin County. Approximately 65,000 years ago, Wisconsinan ice sheets came from the northeast and covered approximately 45 percent of the county. Figure 12 shows the relationships of the Wisconsinan ice sheets that covered Indiana [22]. The ice lobe which affected Franklin County was the lobe that came from the Lake Ontario-Erie region. This lobe was split into two sublobes, named for the predominate drainage sys-

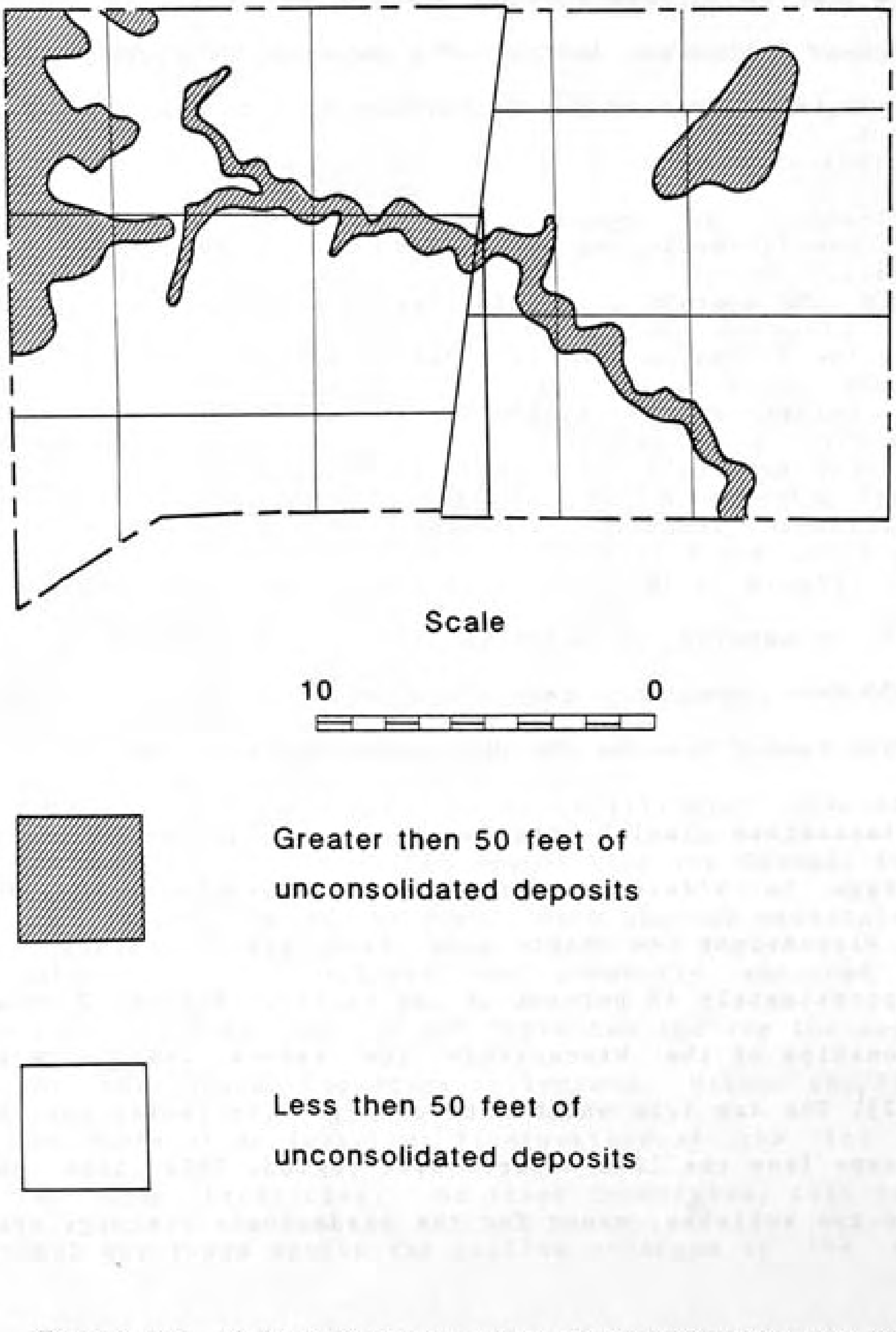


Figure 11. Drift Thickness Map of Franklin County (21).

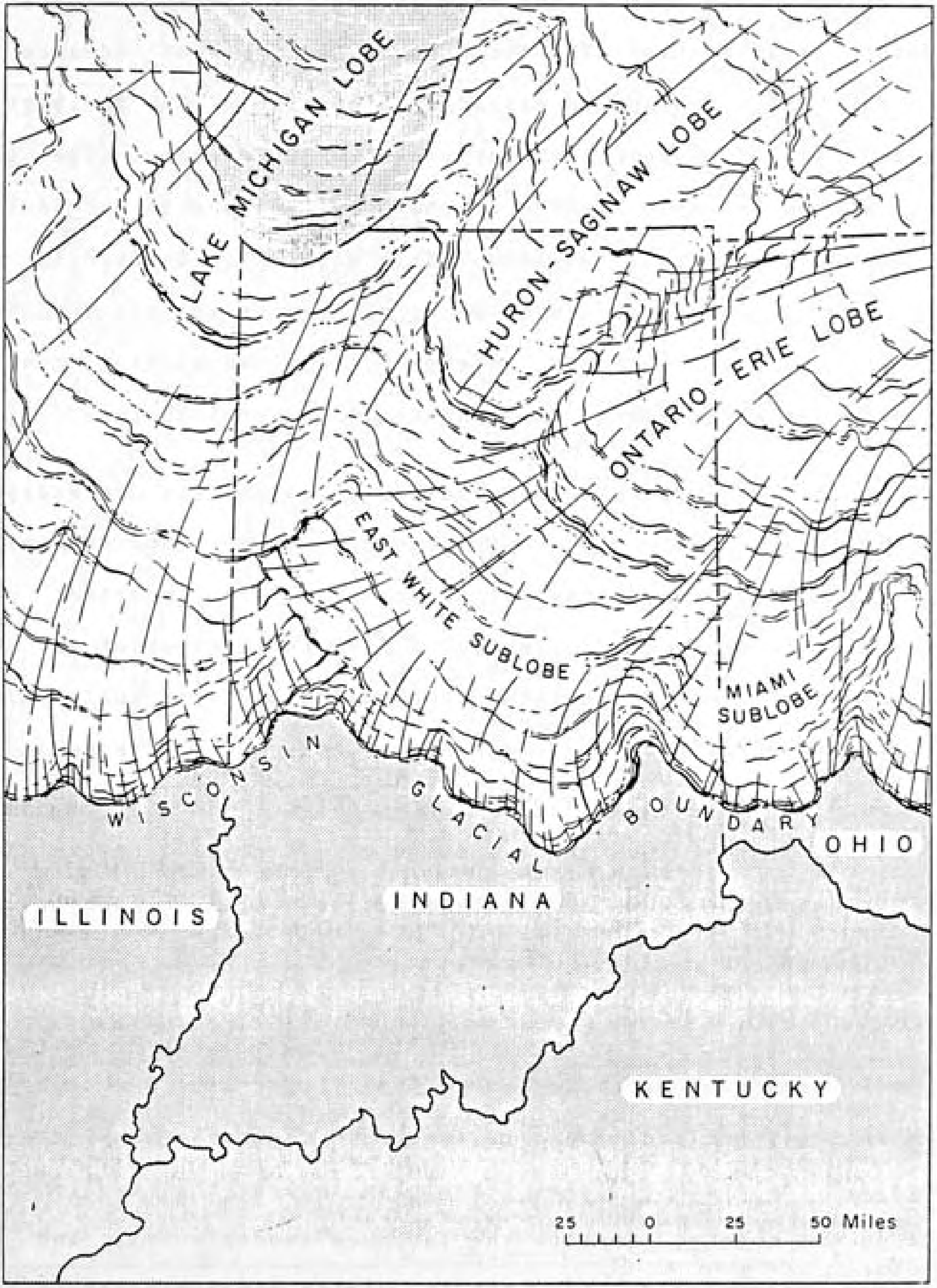


Figure 12. Relationship of Wisconsinan Ice Lobes of Indiana (22)

tems that they affected, the East White and the Miami. There are indications that the active edge of the ice lobes fluctuated at least twice in Indiana. The terminus of the farthest advance of the East White sublobe is marked by a portion of the Shelbyville moraine located in the northwest corner of the county. The terminus of the farthest advance of the Miami sublobe is marked by a portion of the Hartwell moraine. This moraine is located in the central and southeastern section of the county and has the shape of a band across the county. Figure 13 is a map showing glacial deposits and their areal relationships in central Indiana [22].

As the Wisconsinan ice retreated, large amounts of sediment carrying meltwaters flowed through the rivers and streams of Franklin County. The Whitewater River was a very important conduit or sluiceway of meltwaters during the retreat of the ice. Terrace and plains of glacial outwash materials were built along these meltwater carrying waterways [24]. The streams in the county which were affected by the meltwaters today are underfit to their floodplains. The thickness of materials left behind by the retreating and melting glaciers are generally 30 feet or less in thickness.

During the retreat of the ice, strong unchecked winds picked up silt and sand particles out of the floodplains and deposited them as loess and sand dunes in scattered regions of the county. Overall, the depth of loess deposition is less than two to three feet in the county. As with the Yarmouth interglacial, and the Sangamon interglacial the recent period since glaciation is a

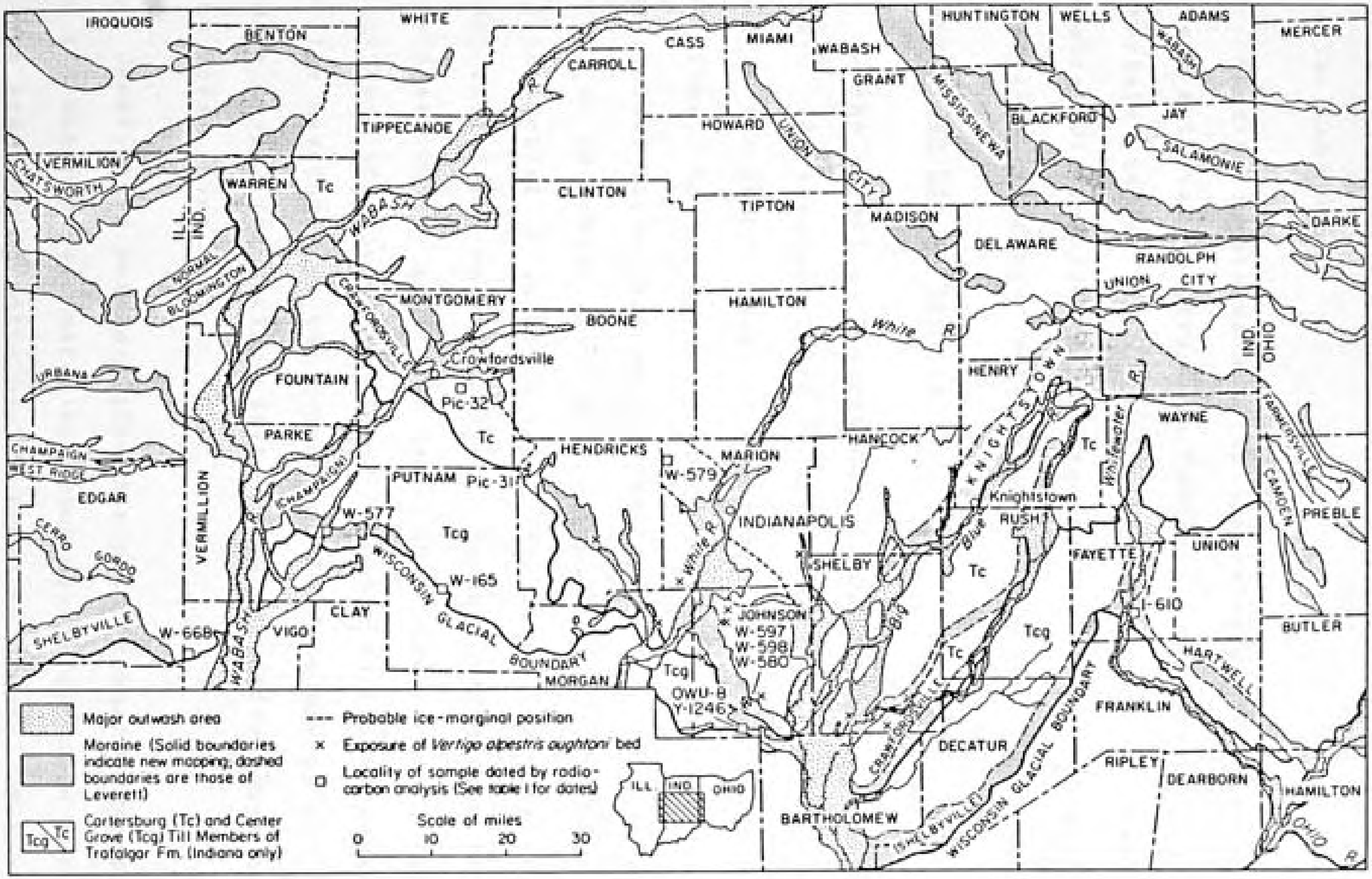


Figure 13. Map of Glacial Deposits in Central Indiana (22)

time of erosion of the Wisconsinan glacial drift.

LANDFORMS AND ENGINEERING SOILS AREAS

GLACIAL LANDFORMS

Glacial landforms make up approximately 80 percent of the parent materials of Franklin County. The types of glacial parent materials mapped in Franklin County are Wisconsinan ground moraine, Wisconsinan ridge moraine, Illinoian ground moraine, and thin Illinoian ground moraine over limestone and shale.

Wisconsinan Ground Moraine

Areas mapped as Wisconsinan ground moraine occupy approximately 20 percent of the county. They are found on the eastern side of the county, east of the Brookville Reservoir and Whitewater River. On the aerial photography, the ground moraine depicts the typical light-dark mottled patterns [25]. The ground moraine forms an extensive plain with a gently undulating surface having a local relief of about 10 feet. In dissected stream valleys, local relief may exceed 15 feet. Loess cover ranges from zero to five feet, but is generally less than two feet. The greater thickness of loess is found closest to the Whitewater River. Gullies developed on the ground moraine are mostly of the broad saucer type indicating silty clays and silty loams common with thin loess cover.

Generalized soil profiles for the Wisconsinan ground moraine and the other parent material types may be found on the left side of the engineering soils map of Franklin County. These profiles were produced using available agricultural and borehole data. The soil profiles show expected variations in the parent material down to a depth of about 12 feet.

The soil profiles for the Wisconsinan ground moraine in Franklin County were divided into two categories. These are high ground moraine and low ground moraines representing generalized subsoil conditions in the rises and in the basins of the Wisconsinan ground moraine surface. Surface soils are generally silty loams (A-4,A-6) down to 10 to 14 inches. The low ground moraine contains more organic material up to eight percent. Subsoils are silty clay loam (A-6,A-7) or clay loam (A-6) down to 42 inches in the high ground moraine and down to 56 inches in the low ground moraine. The underlying material is loam (A-4,A-6) with trace amounts of sand and gravel throughout. Clay contents are greater in the low ground moraines than the high ground moraines throughout their depths.

The agricultural soil series which form in Wisconsinan ground moraine in Franklin County are: Cyclone, Fincastle, Hennepin, Miami, Russell, Sidell, Williamstown and Xenia. Appendix D contains soil borings at various locations in Franklin County. The borings are numbered and may be found on the engineering soils map of Franklin County.

Wisconsinan ground moraine like all glacial drift can be quite variable in composition. The ground moraine generally provides proper foundation bearing capacity for structures. When softer or weathered soils are encounted, undercutting and replacement of these soils may be required. Natural water contents for Wisconsinan ground moraine generally ranges from 6 to 15 percent. These soils in their unweathered state are typically slightly to highly overconsolidated and exhibit higher strength under load. Finally, due to the generally low permeability of the Wisconsinan ground moraine, dewatering of excavations usually is not significant.

Wisconsinan Ridge Moraine

Wisconsinan ridge moraine occupies approximately 20 percent of Franklin County. The ridge moraine was mapped in two different sections of the county. The first section is in the northwest corner of the county and is commonly referred to as part of the Shelbyville moraine. The second section runs in a band from the west side of the Brookville Reservoir, towards the southeast corner of the county. It crosses the Whitewater River south of Brookville and continues on the east side of the river out of the county to the south. This section of ridge moraine is part of the Hartwell moraine. The rolling topography helps define the boundary between Wisconsinan and Illinoian glacial deposits. Ridge moraines in Franklin County rise as much as 35 feet above the surrounding topography.

On the aerial photography, the ridge moraine showed a highly mottled tone. Drainage in the ridge moraine areas is dendritic with saucer-shaped gullies. Loess cover is generally less than two feet.

The soil profile in the ridge moraine area is very similar to the Wisconsinan ground moraine. The surface soils are silty loams (A-4,A-6) down to 8-10 inches. Subsoils are silty clay loams (A-6,A-7) or clay loam (A-6) down to 36 inches. Below this is loam (A-4,A-6) with scattered seams of sand and gravel. Soil boring information was obtained at points 4, 5, 6, and 13 as shown on the map and data reported in Appendix D with reference to each boring number.

Agricultural soil series which form in ridge moraine in Franklin County are: Cyclone, Finecastle, Miami, Russel, Sidell, Williamstown, and Xenia.

Engineering characteristics of ridge moraine are similar to ground moraine. Cut and fill sections with more variable subgrade conditions occur more frequently than on the ground moraine. Natural slopes tend to be steeper. Seepage from perched water tables may increase erosion in cut sections.

Illinoian Ground Moraine

Illinoian ground moraine covers approximately 20% of Franklin County. It is found in the western and central sections of the county. In the Wisconsinan areas, the Illinoian is buried under the younger glacial deposits. The topography of the Illinoian is characterized as nearly flat and heavily dissected. Numerous gullies cut the Illinoian drift contrasting it to the

Wisconsinan which has limited dissection. The weathered profile of the Illinoian may go as deep as 15 feet in the flatter areas of the ground moraine.

On aerial photography, the Illinoian ground moraine appears as a generally flat area with dark photo tones. The gullies are dark-centered and have a characteristic white fringe about them [25]. Gullies are usually of the deep saucer type. Loess cover ranges from 2 to 4 feet.

The surface soils of the Illinoian ground moraine are silty loams (A-4,A-6) down to 2 to 4 feet. Subsurface soils include silty loams grading into unweathered loams (A-4,A-6), silt loams, and clayey silt loams (A-4,A-6). Agricultural soil series which form in Illinoian ground moraine in Franklin County include: Avonburg, Bonnell, Cincinnati, and Rossmoyne.

Engineering properties of the Illinoian ground moraine are similar to the Wisconsinan. The strength of the Illinoian ground moraine will vary with depth. The weathered section will be soft to medium stiff. Below in the unweathered section, the Illinoian is medium stiff to hard. The Illinoian profile is expected to be overconsolidated like the Wisconsinan glacial landforms.

<u>Thin Illinoian Ground Moraine over Limestone and Shales</u>

Thin Illinoian ground moraine over limestone and shales occupy approximately 20 percent of the county. These areas are found in eroded and dissected gullies and stream cuts of the western and central sections of the county. The underlying bedrock is Silurian- and Ordovician-age limestone and shales.

Surface soils in this thin ground moraine are silty loams (A-4, A-6) and loams up to two feet thick. Loess cover ranges from 0 to 2 feet in thickness. Underlying soils include clay loams (A-6), silty clay loams (A-4,A-6), and silty loams (A-4,A-6) down to as much as 12 feet. Interbedded limestone and shales are generally encountered within 3 to 12 feet of the surface.

Agricultural soil series which form over thin Illinoian ground moraine over limestone and shale include: Avonburg, Bonnell, Cincinnati, and Rossmoyne.

Engineering properties of the thin Illinoian are similar to the Illinoian ground moraine. The underlying bedrock is competent with a weathered surface that extends down about 2 to 3 feet into the rock. The limestone rock is generally not solution susceptible. Weathering of the thin Illinoian is expected to extend down to the bedrock surface except where the bedrock exceeds a depth of 15 feet below the surface.

EOLIAN LANDFORMS

<u>Loess Plain</u>

Loess covers most of Franklin County except for steep eroded slopes and recent alluvial deposits. However, the loess is not thick enough to be mapped as a distinct parent material type. The average thickness of the loess cover in Franklin County is approximately 2.5 feet. Loess cover upon the Wisconsinan age drift averages less than two feet. Given the rolling nature of the Wisconsinan moraines, this loess cover may vary from five inches to as much as 60 inches in some areas. Older outwash terraces close to the Whitewater River have 2 to 3 feet of loess. The Illinoian ground moraine has 2 to 4 feet of loess.

Loess soils are generally silt loams, clay loams, or silty clay loam. They are classified as ML, ML-CL or CL by the unified system. In there unweathered state, they generally show a non-cohesive nature and have a high porosity and permeability. Upon wetting, loess soils can be susceptible to a variety of problems. These problems include: collapse due to settlement or bearing capacity failure when the cementing in the loess breaks down; frost heave of the silt, which is very frost-susceptible; piping in excavations; and pumping. Since the loess is generally thin, however, if problems of these types are anticipated, removal of the loess should be considered.

<u>Sand with Incipient Dune Development</u>

Sand dunes and wind-blown sand deposits have developed at scattered locations within Franklin County. The two primary areas of sand development are near Laurel and Brookville. Near Larrel sand is found on both the east and west sides of the west Fork Whitewater River. Southeast of Brookville, windblown sand is found along the bluffs of the Whitewater valley. Other dunes may be found scattered close to the Whitewater River valley. At the present time in the county, active eolian deposition and development are minimal.

The sand dunes of Franklin County rest upon outwash terraces and glacial drift. Overall, the dune development is of a low magnitude. In areas mapped as sand dunes, the thickness of sand ranges from 5 to 15 feet. Dunes on outwash terraces generally show the greater thicknesses of sand and largest number of dunes. The dunes that have developed on glacial areas rest on the first ridges of glacial tills adjacent to the valleys. These glacial tills are of both Wisconsinan and Illinoian age and rest upon the bluffs of the Whitewater River. Stratigraphic contacts between the sand and the underlying parent material is expected to be sharp in glacial areas and gradational in terrace areas.

The predominate parent material of sand dunes is windblown sand. It is possible to have silt, however, as part of the parent material. The surface soil in sand dune areas is a sandy loam (A-4,A-6) down to 24 inches. Subsoils have a slightly higher clay content due to weathering and may be sandy clay loams (A-6), sandy loams (A-4,A-6), or sand (A-3) down to about 42 inches. The subsurface soils are sand (A-3) or sandy loam, which grade into sandy loams or gravelly sands of terraces or a silty loams, silty clay loams, or clay loams of glacial tills.

The sand in dunes and other windblown deposits are loose and noncohesive. Since they are of a generally uniform size or gradation, compaction of these soils may be difficult. In addition, given their uniform gradation, the porosity and permeability of these deposits are high.

The agricultural soil series which forms on sand dunes in Franklin County is the Princeton series.

BEDROCK LANDFORMS

Interbedded Limestones and Shales Along Valley Walls and Benches

Interbedded limestones and shales of Ordovician, and to a lesser extent Silurian, occupy a total of about 12 percent of the area of the county. This landform type is found adjacent to rivers, streams, and small drainageways on sloping to very steep areas of valley walls and benches. These sloping to very steep areas, generally experience or have experienced intense erosion; thus, bedrock is at a very shallow depth. The depth to bedrock is usually less than 25 inches [2]. In sections of the valley wall of the Whitewater River, the bedrock outcrops on the steep slopes.

The residual soils that may form over these interbedded rocks are poorly developed. The surface may be rock or may be a surface soil. These surface soils are generally silty loams (A-4,A-6), silty clay loams (A-6,A-7), or clay loams (A-7). Underlying soils are usually very plastic clay loams. Loess cover ranges from zero to two feet. The clayey soils are usually the result of the weathering of the bedrock. The silty soils may result from loess and potentially from weathering of the bedrock. The agricultural soil series which form on the interbedded limestones and shales in Franklin County include Carmel, Eden, and Winn.

Profile borings were made in this region as indicated by numbers 11, 12, 14, 15 and 16 on the map. In Appendix D, under these same numbers, specific data are reported for each site.

The limestone rock generally is competent and susceptible to solutioning. The shale, however, weathers easier. Slope failure may occur with sliding of the rock. This will be discussed further in the engineering problems section.

GLACIO-FLUVIAL LANDFORMS

Terraces

Areas mapped as terraces in Franklin County are found at numerous locations within the Whitewater River valley and its major tributaries. Outwash terraces and river terraces were lumped together and mapped as terraces. Glacio-fluvial terraces are outwash terraces. These terraces are formed from gravel, sand, and silt, which were carried away from the glacier by meltwater streams. In Franklin County, several elevations of terraces may be along the sides of the Whitewater River. The terraces stand 10 to 75 feet above the current floodplain of the river. These terraces of glacio-fluvial drift may contain in excess of 100 feet of sand and gravel materials [2].

The outwash terraces appear on the aerial photography to be flat or gently undulating surfaces above the floodplains. Overall photo tone is light gray, with old current markings and infiltration basins being visable on most. The outwash terraces have been used extensively as aggregate sources. Gravel pits have altered the surface of many outwash terraces. Sand dunes are also common on the terraces with concentrations near Laurel and Brookville.

The profile of glacio-fluvial terraces may be quite variable. Surface soils may be silt loams (A-4,A-6), silty clay loams (A-6,A-7), or loam (A-4,A-6) down to about four feet. Underlying soils include gravelly clay loam, sand loam, or gravelly loam down to about 72 inches. Underlying this is generally mixes of loamy stratified sand and gravel (A-2) or stratified sand and gravel (A-1). The higher the terrace above the present floodplain, the longer the soil-forming processes have changed the material. The higher terraces will have a deeper and better developed soil profile. Agricultural soil series which form on outwash terraces include Fox, Ockley, and Rodman.

River terraces may be found in the steams of the Illinoian drift areas and in the very low terraces of the Whitewater system. These terraces are usually less than five feet above the floodplain. They were formally floodplain which now are not flooded. Their soil profiles are quite variable like the outwash terrace. Agricultural soil series which form on river terraces include the Alvin and the Eldean series.

FLUVIAL LANDFORMS

Floodplains

Floodplain soils are very hard to characterize due to their potentially variable behavior even over short distances and depths. The floodplains of Franklin County are divided into three types for discussion. Agricultural soil series which form on floodplains in Franklin County include: Dearborn, Gessie, Holton, Moundhaven, Oldenburg, Ross and Wint.

(a) Whitewater River Floodplains

The main river in Franklin County is the Whitewater River. Topographically, its floodplain is very flat. The width of the floodplain averages about one-half of a mile. On aerial photography, the floodplain has variable photo tones. Other river associated features such as sand bars and meander scars may be seen at various location within the floodplain. Organic materials may be found near the surface, but are less common in the subsoil. The floodplain of the Whitewater River overlies a variety of materials. These include Ordovician limestone and shales, Wisconsinan glacial drift, and Illinoian glacial drift. The total depth of filling of the bedrock valley in which the Whitewater River flows, by fluvial and glacial materials, may be as much as 150 feet.

Surface soils of these floodplains consist of sandy loams (A-4,A-6,A-2), silty clay loams (A-6,A-7), or silty loams (A-

4,A-6). Subsoils consist of silty clay loams, silty loams, and loams. Lenses of sand and gravel may be found at depth. In some localities, the river flows directly over bedrock.

(b) Floodplains in Wisconsinan Drift Areas

Soils of the floodplains in Wisconsinan drift areas are derived from the erosion of loess, Wisconsinan drift, bedrock, and outwash materials. Floodplain widths are generally less than a few hundred feet across.

The first 14 to 24 inches of the floodplain soils in Wisconsinan areas are silty loams (A-4,A-6), clay loams with some organics (A-7), or silty clay loams with slight organics (A-6,A-7). Under these soils, down to 32 to 72 inches, are loams which are silty and stratified or clayey in sections. These grade into gravelly sand loam or gravelly sand. In some floodplains, interbedded limestone and shales may be encountered at six feet.

(c) Floodplains in Illinoian Drift Areas

The floodplains in Illinoian drift areas contain soils which are derived from Illinoian ground moraine, thin loess, and residual bedrock. Most floodplains in Illinoian drift areas may be several hundred feet in width. On aerial photograph, floodplains in Illinoian drift areas contain a white fringe about their perimeter.

Surface soils in Illinoian drift floodplains are silt loam (A-4,A-6), silty clay loam (A-4,A-7), and clay loam (A-7). In

Illinoian ground moraine areas, underlying soils are loam with silt and clay seams, and sandy loam with traces of gravel. Floodplains in drift over limestone and shale have subsoils consisting of sandy loams and interbedded bedrock at 48 to 72 inches.

Soil borings in the various floodplains are indicated at sites 7, 8, 9, 10, 17, 18, 19, and 20. Data for each boring site are contained in Appendix D corresponding to each number.

<u>River Terraces</u>

As stated earlier, river terraces were lumped together with outwash terraces and called terraces on the engineering soils map and in the soil profiles. Fluvial materials, like the materials which make up the floodplains and river terraces, are generally moderately plastic in the surface soils. The fluvial materials generally have non-uniform strength due to their compositional variability.

MISCELLANEOUS LANDFORMS

<u>Gravel Pits and Quarries</u>

Several gravel pits and limestones quarries are found in Franklin County. The gravel pits are scattered along the Whitewater River in terraces which contain deep deposits of sand and gravel suitable as aggregate. Several limestone quarries are also located in the county. One quarry is located near Laurel. Limestone from various quarries in the county are used for crushed stone, agricultural lime, and building stone.

ENGINEERING PROBLEMS AND CONSIDERATIONS IN FRANKLIN COUNTY

INTRODUCTION

This section is a discussion of possible engineering problems associated with the landform-parent material areas mapped in Franklin County. Figure 14 is a summary of engineering properties of soils [27].

GROUNDWATER SUPPLY

Franklin County is located in the Ordovician Limestone and Shales Groundwater Section of Indiana [7]. A portion of the groundwater in the county is obtained from deep limestone bedrock aquifers. The depth of these wells generally exceed 200 feet. Water obtained from these bedrock aquifers is of good quality [2]. Bedrock is not the only source of water in the county. Wells driven into the upland areas of glacial drift range from 25 to 200 feet or more in depth. These are successful if a substrata of water-bearing sand or gravel can be found. Glaciofluvial terraces are drilled for water to a depth of 15 to 100 feet along the Whitewater River. There is generally good success in obtaining water from these terraces. The final water source is surface supplies. Ponds and the Brookville Reservoir provide water for various activities in the county. In general, water is readily available in most all areas of the county.

ENGINEERING PROPERTIES OF SOILS SUMMARIZED				
Property	**Gravel and sand**	**Silt**	**Clay**	**Organics**
		HYDRAULIC PROPERTIES		
Permeability	Very high to high	Low	Very low to impermeable	Very high to very low
Capillarity	Negligible	High	Very high	Low to high
Frost-heaving susceptibility	Nil to low	High	High	Low to high
Liquefaction susceptibility	Nil to high in fine sands	High	None	High in organic silts
		RUPTURE STRENGTH		
Derivation	Intergranular friction ϕ	Friction ϕ, apparent cohesion	Drained: $\bar{\phi}$ and $\bar{c}$; undrained: s_u	Organic silts and clay, ϕ and c
Relative strength	High to moderate	Moderate to low	High to very low	Very low
Sensitivity	None	None	Low to very high	As for clay
Collapsing formations	Lightly cemented sands	Loess	Porous clays	Not applicable
		DEFORMABILITY		
Magnitude (moderate loads)	Low to moderate	Moderate	Moderate to high	Very high
Time delay	None	Slight	Long	None to long
Compactability	Excellent	Very difficult	Moderate difficulty; requires careful moisture control	Not applicable
Expansion by wetting	None	None	Moderate to very high	Slight
Shrinkage upon drying	None	Slight	Moderate to very high	High to very high
		CORROSIVITY		
	Occasional; calcareous sands troublesome to concrete	Occasional	Low to high	High to very high

Figure 14. Engineering Properties of Soils (27).

FROST ACTION POTENTIAL

Several parent material types have a moderate or high probability for frost heave. These are the Wisconsinan ground moraine and ridge moraine, the Illinoian ground moraine, and the thin Illinoian moraine over bedrock. All of these may contain substantial amounts of clays and especially silts. They are generally poorly drained and are susceptible to frost action. Frost heave during freezing and induced low shear strength during thawing can damage rigid structures, such as pavements. Care should be taken to provide either adequate drainage and/or increased insulating materials to frost susceptible soils.

STEEL AND CONCRETE CORROSION

Forty percent of the parent materials in Franklin County contain soils with a high to moderately high potential for steel and concrete corrosion. These include the Illinoian ground moraine, thin Illinoian drift over bedrock, floodplains in Illinoian drift areas, and limestone benches. The pH of these soils range between 4.5 to 8.4 [2]. Acidic conditions present in these soils reduces the lifespan of buried metal pipe from 40 to 15 years [30]. Aluminum pipe is often used to minimize the corrosion effects. It should be emphasized that site specific evaluation of potential metal corrosion should be considered.

Most severe concrete corrosion is due to a poor quality of concrete. Thus, in areas where this is potentially a problem, good quality concrete will help eliminate corrosion and structural damage.

WASTE DISPOSAL

There are several landforms in Franklin County which need to be avoided when planning solid or liquid waste disposal systems. A waste disposal system may be a sanitary landfill or a septic system. The first landform type is the terraces. Terraces are much too permeable to serve as candidates for landfills and septic tanks. Leachate can easily drain through the granular materials of the terrace and contaminate groundwater. The sand dune areas are not practical for the same reasons. Floodplains are to be avoided as waste system sites because they are frequently flooded which leads to escape of contaminated leachate. Finally, areas with bedrock close to the surface such as the thin Illinoian drift over interbedded limestones and shales are potentially bad. Limestone should be avoided. Shale should be avoided if secondary porosity and sufficient permeability is present to lead to travel of the leachate.

The upland Wisconsinan and Illinoian areas provide the best sites for locations of these systems if the tills are relatively thick. They have, generally, low permeabilities and contain sufficient fines for cover.

FOUNDATIONS AND EXCAVATIONS

Almost all of the soils in Franklin County have a low probabilty of engineering problems associated with foundations and excavations. Areas which generally experience some design and performance problems with foundations and excavations include the floodplains, the limestone benches, and possibly the thin Illinoian drift over bedrock areas.

Foundation and excavation problems are common in the floodplain areas. The floodplain soils are highly permeable and require dewatering. Excavations often experience slope failure thus there is a need for adequate bracing of the slopes. Blowouts are another common problem which should be anticipated. In some of these floodplain areas, bedrock is relatively close to the surface and foundations are designed to rest upon competent bedrock.

Exposure of the interbedded limestones and shales in the western part of the county causes shale degradation and slope failures. Steps should be taken to protect the shale from the environment, when the possibility of degradation exists.

Other potential problems of the engineering soils of the county include perched water tables and ensuing slope stability problems in the ridge moraine. Also, there is the probability of need for dewatering in deep excavations in the terraces. Also, terraces should be explored for local loose sand seams or clay pockets.

Few problems are anticipated with building of structures and excavation of materials in the Wisconsinan and Illinoian ground moraine areas. These moraines are naturally overconsolidated, an important point for consolidation and settlement considerations in building systems. To ensure proper foundation performance, a careful site investigation should be undertaken to alleviate future problems. Glacial till can be very variable over a short distance. Thus, soil exploration for new buildings in these areas is needed for identification of materials with low bearing capacity and high settlement potential.

LANDSLIDES

Franklin County has had some problems with slope stability and landslides within the steep valley wall slopes of the Whitewater River. There are four ways in which slopes may be made or may become unstable. These are: oversteeped slopes in a cut section, overloading of the head of a steep slope, removal of toe support, and saturation of the slope. In the Franklin County landslides, these as well as other factors have come into play.

One documented slide occurred on U.S. 52 approximately 10.2 miles south of S.R. 101 [28]. At this site, the landform type is Wisconsinan ground moraine underlain at 28 feet by a soft to hard shale interbedded with limestone. The bedrock surface slopes at 3:1 towards the Whitewater River. A retaining wall was built at the bottom of the slide area. The soil slid and destroyed the retaining wall. After this instability was analyzed, two factors were found to be responsible for the slide. First the water table reduced the shear strength of the soil and increased the driving force of the soil mass. Second, toe material was removed during construction of the wall.

Another documented slide occurred on U.S. 52 about 2.8 miles west of S.R. 46 [29]. The geology and site conditions are similar to the first slide presented. At this location, an embankment failed. The groundwater table at both locations fluctuates with changes in precipitation. After analysis of this failure, the engineer identified four possible factors that contributed to the failure. First, the embankment was compacted wetter or drier than needed. Compacting wet reduces the strength. When a soil is compacted dry, it will be fine until it absorbs water. When it absorbs water, expansion of the soil lowers the strength. Second, weathered rock and mixtures of soil and rock were not handled correctly in the cut and fill procedure used. Third, the bedrock surface slopes towards the river. And finally, the groundwater reduces strength and increases the driving force.

At both of the above locations, the solution of the problem was extra support to the slope and refilling of the embankment or slope to stop instability. When cuts are made or when natural slopes exists that may cause damage to a structure, precautions can be taken that may prevent slope failures. First, when making cuts a slope of 2:1 to 3:1 generally gives an adequate amount of safety in most materials. Second, proper drainage of slopes is very important. Groundwater has an impact in most all slope failures. Third, before removing material from the toe of a slope make sure that the passive resistance is still high enough to insure a proper factor of safety. Also, before adding any additional load to the top of the slope be sure to analyze the extra driving force that will be induced upon the slope soils. More support may be needed at the toe to insure safety. And finally, before using rock fill, know how the rock will compact and how it will behave in the long term. Shales are often used in embankments and foundations in Franklin County. Shales in the southeastern part of Indiana are known for degrading when exposed to the environment. The next section looks at this problem.

SHALE EMBANKMENT AND DEGRADATION

Shales occurring in Franklin County could cause problems if used in embankments or if these materials occur in natural slopes. Testing of shale materials to be used in rock fills to check their tendency to degrade after placement is required. When these materials are placed and compacted, large voids exist. As the shale is exposed to the environment, it becomes soft and its collapsing void spaces causes large settlement and slope failure. Fortunately, a rating system has been devised to determine the shale suitability as a fill material [32]. Specific tests are performed upon the shale to rate it for comparison with correlation charts. These charts correlate the shale rating with common design practice.

The first test performed upon the shale is the slake durability test. This test evaluates durability and long term degradation due to weathering. Five ten-gram samples of shales are placed in a wire drum , submerged half-way in water, and rotated 200 revolutions. The drum is then oven dried before repeating the rotation. After the second set of rotations, the pieces of shale remaining are weighed. The shale durability index, I(d), is then computed as follows:

$$I(d) = \frac{\text{Weight after second cycle X 100}}{\text{Weight after first cycle}}$$

This results in a number between 0 to 100. Shales with an I(d) < 80 are considered soil-like and the plasticity index is determined. Shales with an I(d) > 80 are considered rock-like and a point load test is performed.

Franklin developed a rating chart using index of durability versus plasticity index or point load test. Figure 15 is the Franklin rating chart and is used to determine a 'R' value [32]. Figure 16a shows minimum lift thickness and compacted density verses the 'R' value. Figure 16b shows the correlation between the drained shear strength parameters and the 'R' value. These charts can be used to predict shale performance.

Most of the Ordovician-age shales are considered rock-like shales but in the long term they may break down and be soil-like. If problems are expected with using a shale as a rock-type material, precautions are taken to lessen degradation effects. Proper drainage within the fill helps to minimize slaking. Also,

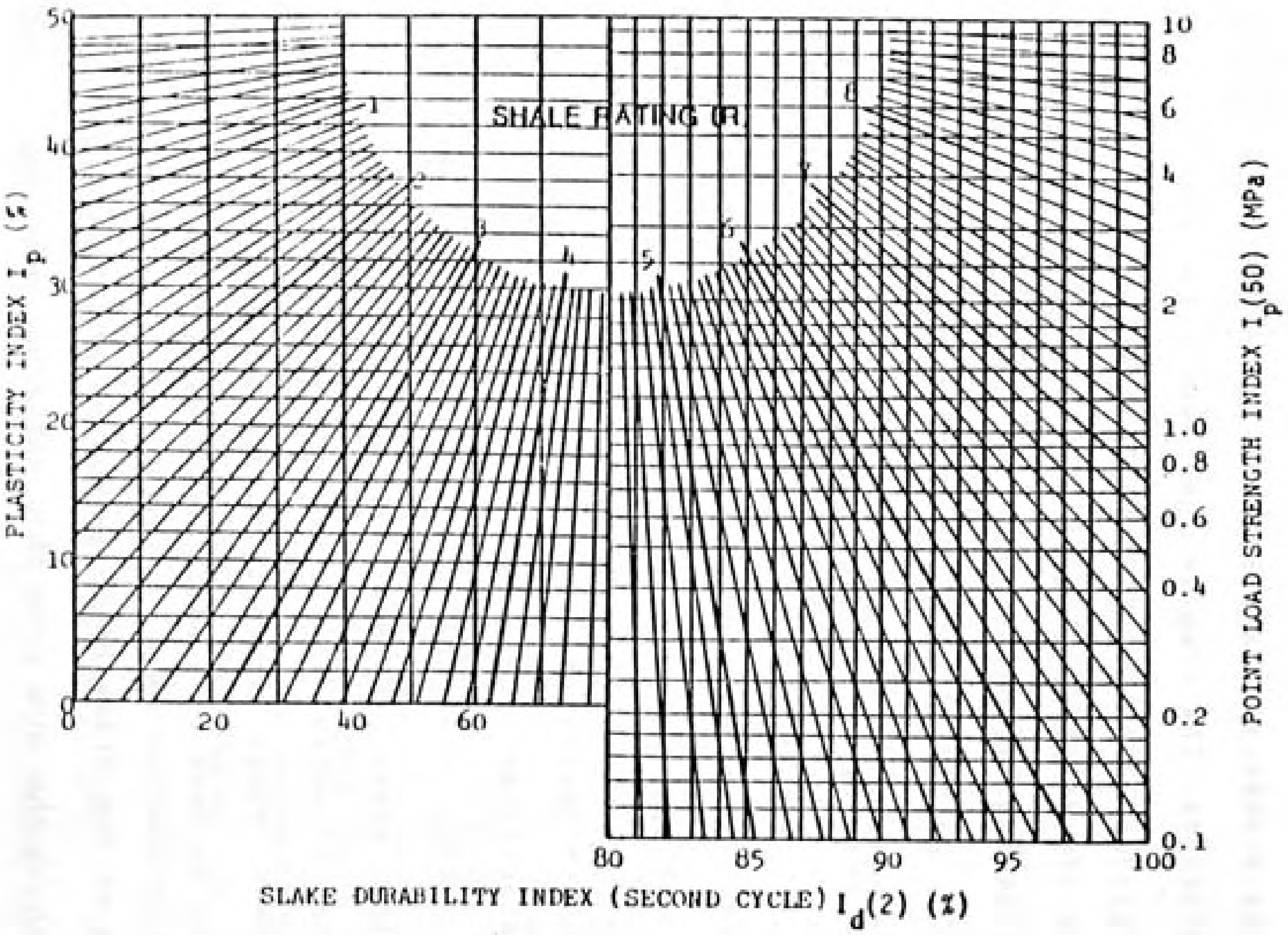


Figure 15. Franklin's Shale Rating Chart (32).

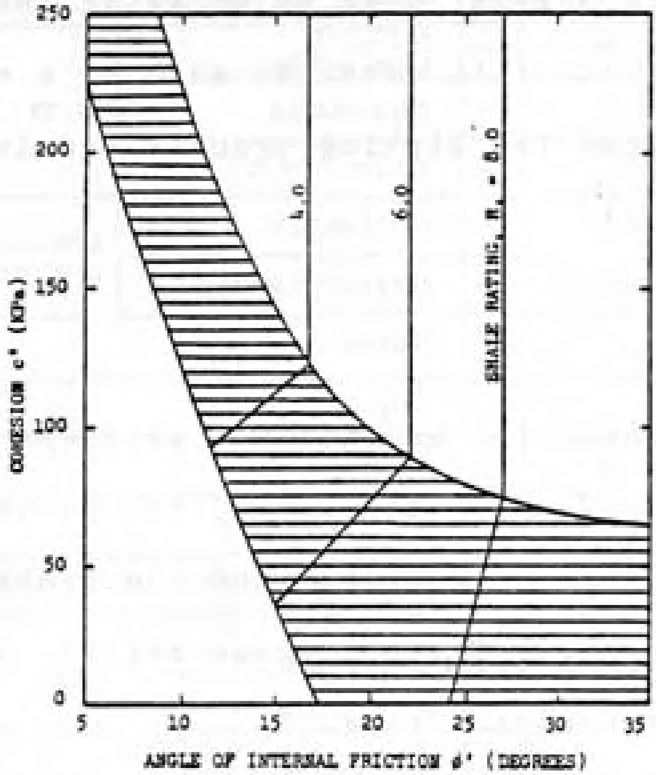


Figure 16a. Trends in Shear Strength Parameters of Compacted Shale Fills as a Function of the Shale Quality (32).

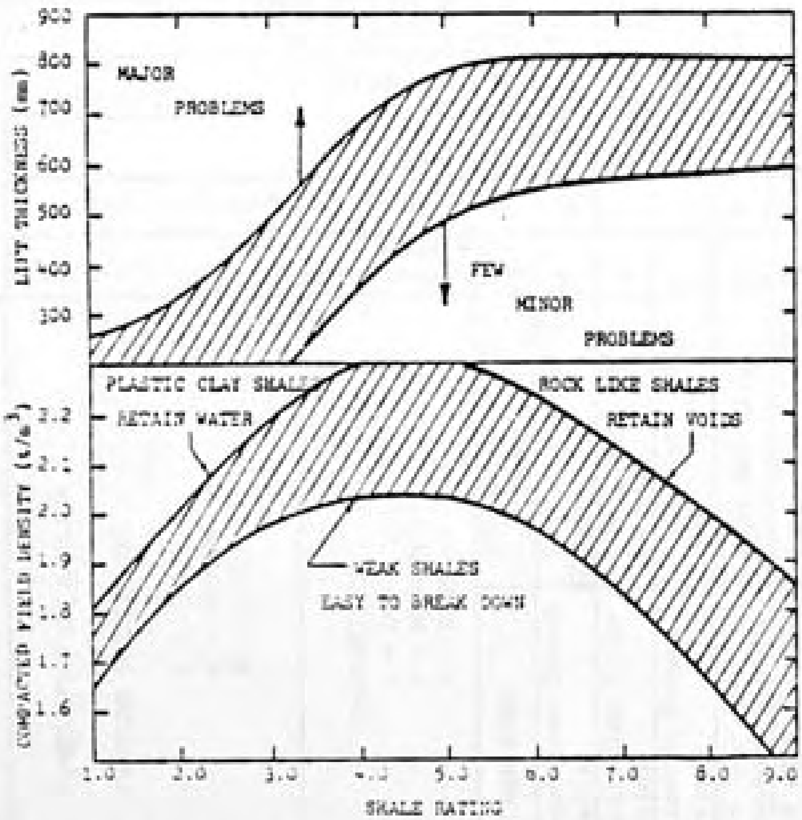


Figure 16b. Tentative Correlations Between Shale Quality, Lift Thickness, and Compactd Densities (32).

the shale fill is isolated from water infiltration and from the environment. This is accomplished by encasing the shale with a very low permeability fill material such as a clay. These measures help to slow down the slaking process and increase the service life of the fill.

SUMMARY

A summary of potential engineering problems related to the soils of Franklin County is given in Table 5. Each parent material type is represented along with the probability of certain problems occurring. These ratings reflect the average character of the parent material type.

Table 5. Summary of Engineering Problems of Franklin County.

SYMBOL EXPLANATION		CUT DESIGN					EMBANKMENT FILL					EMBANKMENT FOUNDATION			HIGHWAY SUBGRADE				FOUNDATION DESIGN					MISCELLA-NEOUS		
LIKELIHOOD OF A MAJOR PROBLEM DEVELOPING L - LOW M - MEDIUM H - HIGH								COMPACTED PROPERTIES											SHALLOW FOOTINGS		PILES					
PERMEABILITY 1 - LOW 2 - MEDIUM 3 - HIGH																										
LAND FORM	GENERAL SOIL TEXTURE	SOIL/ROCK BACKSLOPE STABILITY	GROUNDWATER CONTROL	EROSION	SURFACE DRAINAGE	NATURAL SLOPE AND RIVER BANK STABILITY	EROSION	RELATIVE PERMEABILITY	SHEAR STRENGTH	COMPRESSIBILITY WHEN SATURATED	WORKABILITY	SETTLEMENTS	SHEAR STRENGTH	ORGANIC DEPOSITS	SUBGRADE SUPPORT	FROST ACTION	PUMPING	SHRINK-SWELL	BEARING CAPACITY	SETTLEMENTS	BEARING CAPACITY	SETTLEMENTS	NEGATIVE SKIN FRICTION	SHALLOW RESIDENTIAL SEPTIC SYSTEMS	STEEL CORROSIVITY	CONCRETE CORROSIVITY
Wisconsinan Ground Moraine	Silt, Clay and Sand	L	L	L/M	M	L	M	1	L/M	M	L	L	L	L/M	L	M/H	M	M	L	L	L	L	L	M/H	L	L
Wisconsinan Ridge Moraine	Silt, Sand and Gravel	L	L	L/M	M	L/M	M	1	L/M	M	L	L	L	L	L	M/H	H	M	L	L	L	L	L	M/H	L	L
Illinoian Ground Moraine	Silt, Sand and Clay	L	M	M	M	L	M	1	L/M	M/L	M/H	L/M	L/M	L	L	M/H	H	M	L	L	L	L	L	H	M	H
Thin Ill. over Limestone & Shale	Silt and Clay	L	L	M	M	M	M	1-2	L/M	M/L	M/H	L/M	L/M	L	L	M/H	M	M	L	L	L	L	L	H	M	H
Sand with Incipient Dune Development	Sand, Silt & Sand	L	M	H	L	L	H	3	L	L	L	L	L	L	L	L/M	L	L	L	L	L	L	L	H	L	L
Terraces	Sand, Silt and Gravel	L	M/H	M	L	L	M	3	L	L	L	L	L	L/M	L	L/M	L	L	L	L	L	L	L	L	L	L
White Water River Flood Plain	Sand, Silt and Gravel	M	M	H	L/M	M	M	1-3	M	M	M/L	H/L	H/M	M/H	M	M	M/L	L	M/H	M	L/M	L/M	M	H	L	M
Flood Plains in Ill. Grd. Moraine	Silt, Sand, Gravel and slight Clay	M	L/M	M	M/L	L	M	1-2	M	M	M/L	H/L	H/M	M/H	M	M	M/L	L	M/H	M	M	M	M	M	M	M
Flood Plains in Wisc. Grd. Moraine	Silt, Sand, Gravel and slight Clay	M	M	M/H	M/L	L/M	M	1-2	M	M	M/L	H/L	H/M	M/H	M	M	M/L	L	M/H	M	M	M	M	M	L	L
Limestone / Shale	Rock	L	L	L	H	L	L	1	L	L	H/M	L	L	L	L	M	L	L	L	L	L	L	L	-	M	L

REFERENCES

1. Frost, R.E., et. al., "Manual on the Airphoto Interpretation of Soils and Rocks for Engineering Purposes," JHRP, Purdue University, West Lafayette, Indiana, 1943.

2. "Soil Survey for Franklin County, Indiana",U.S. Department of Agriculture, Soil Conservation Service in Cooperation with Purdue University Agricultural Experimental Station,May 1950.

3. "Soil Survey for Franklin County, Indiana", U.S. Department of Agriculture, Soil Conservation Service in Cooperation with Purdue University Agricultural Experimental Station, due out in 1989.

4. Hittle, J.H., "Population Trends for Indiana Counties, Cities, Towns 1970-1980," Highway Extension and Research Project for Indiana Counties, 1981.

5. "Climatological Summary",U.S. Department of Commerce,Weather Bureau in Cooperation with Purdue Agricultural Experimental Station, Climatology of the U.S. No. 20-12,. Brookville, Indiana, 1934-1963.

6. Parvis, M., "Drainage Map of Franklin County, Indiana", Joint Highway Research Project, Purdue University, 1947.

7. Perrey, J.I., et. al., "Indiana's Water Resources", Indiana Flood Control and Water Resources Commission, Bulletin No. 1, June, 1951.

8. Parvis,M.,"Airphoto Interpretation of Drainage Features of Franklin County, Indiana", Joint Highway Research Project No. R-63,Purdue University,1947.

9. "Drainage Density Data of Selected Streams in Indiana", Indiana Department of Natural Resources Division of Water, 1976.

10. Horner, R.G., "Statistical Summaries of Indiana Streamflow Data," U.S.G.S., Water-Resources Investigations 35-75, February 1976.

11. Rohne, P.B., "Low-Flow Characteristics of Indiana Streams," United States Geological Survey, Open-File Report, 1932.

12. Schneider, A.F., "Physiography", Reprint Indiana Sesquicentennial Volume, Natural Resources of Indiana, Indiana Academy of Sciences, 1966.

13. Logan, W.N., et. al., "Handbook of Indiana Geology," Indiana Dept. of Conservation, Div. of Geology, Indianapolis, Indiana, 1922.

14. Patton, Miscellaneous Map 13, 1955.

15. "Regional Topographic Map, Cincinnati Sheet", prepared by the Army Map Service, Corps of Engineers, U.S. Army, Washington D.C., 1954.

16. Shaver, R.H., et. al., "Compendium of Paleozoic Rock-Unit Stratigraphy in Indiana-A Revision," Dept. of Natural Resources, Geological Survey, Bulletin No. 59, Bloomington, Indiana, 1986.

17. Greeman, Theodore K., "Lineaments and Fracture Traces, Decatur County, Indiana", U.S. Geological Survey in Cooperation with Indiana Department of Natural Resources and Decatur County, Open-file Report 82-918, 1983.

18. Gray, H.H. et al, "Geologic Map of the Cincinnati and Indianapolis 1 x 2 degree Quadrangles Showing Bedrock and Unconsolidated Deposits", Department of Natural Resources, Geological Survey, Bloomington, Indiana, 1972.

19. Gray, H.H., "Map of Indiana Showing Topography of the Bedrock Surface," Indiana Dept. of Natural Resources Geological Survey, Bloomington, Indiana, 1982.

20. Wayne, William J., "Ice and Land : A Review of the Tertiarry and Pleistocene History of Indiana", Reprint, Indiana Sesquicentennial Volume, Natural Features of Indiana, Indiana Academy of Sciences, 1966.

21. Wayne,W.J.,"Thickness of Drift and Bedrock Physiography of Indiana North of the Wisconsin Glacial Boundary", Indiana Department of Conservation Geological Survey Report of Progress No. 7, 1956.

22. Gray, H.H., "Map of Indiana Showing Thickness of Unconsolidated Deposits," Indiana Dept. of Natural Resources, Geological Survey, Bloomington, Indiana, 1983.

23. Wayne, William J., "The Crawfordsville and Knightstown Moraines in Indiana", Geological Survey Progress Report No. 28, Indiana Department of Conservation, 1965.

24. Gooding,Ansel M.,"Characterists of Late Wisconsinan Tills in Eastern Indiana",Department of Natural Resources Geological Survey Bulletin No. 49, 1973.

25. Thornbury, W.D., "Glacial Sluiceways and Lacustrine Plains of Southern Indiana," Bulletin No. 4, Division of

Geological., Department of Conservation, Bloomington, Indiana, June 1950.

26. Miles, R.D., CE 567 Class Notes, Purdue University.

27. Hunt, R.E., Geotechnical Engineering Investigation Manual, McGraw-Hill, 1984.

28. "Report of Landslide Correction, ST-Project No. ST-082-6(B), U.S.52 approximately 10.1 miles south of S.R.101 in Franklin County", prepared by the Indiana Department of Highways Division of Materials and Testing,Geotechnical Section, May 1985.

29. "Report of Landslide Correction, U.S. 52 approximately 2.8 miles west of S.R. 46 in Franklin County, prepared by the Indiana Department of Highways Division of Materials and Testing, Geotechnical Section, October 1985.

30. Frey, L.J., "Engineering Soils Report of Brown County, Indiana", Final Report, Joint Highway Research Project, Purdue University, Indiana State Highway Commission, Joint Highway Research Report No. 1-52-73

31. Tyree, J.L., "Engineering Soils Report of Bartholomew County, Indiana", Final Report Joint Highway Research Project, Purdue University, Indiana State Highway Commission, Joint Highway Research # 1-5-2-78

32. Oakland, M.W., and Lovell, C.W., "Classification and Other Standard Tests for Shale Embankments, " MSCE Thesis and Joint Highway Research Project # 76-21, Purdue University, West Lafayette, IN, February 2, 1982.

33. "Geotechnical Investigation Project No. F-082-6(9), U.S. 52 over Whitewater Canal in Franklin County", prepared by E.T.S., Inc. Indianapolis, Indiana, April 1988.

34. "Report of Roadway Soil Survey, AHL-Project No. 1(1) P.E.; Brookville Lake Access Road No. 1 (Fairfield Road) in Franklin County", by Indiana State Highway Commission Division of Materials and Tests, Soils Department, November 1977.

35. "Soils Survey Investigation, BRS-Project No. 8524(1), Blue Creek Road over Whitewater River, Franklin County, Indiana", prepared for Howard J. Barth and Associates, Inc. by E.T.S., Inc. Indianapolis, Indiana, October 1982.

36. "Report of Geotechnical Investigation, Project No. RS 196(2) S.R. 252, Franklin County", Indiana prepared for Indiana State Highway Commission by the H. C. Nutting Co., March 1976.

37. "Subsurface Investigation and Soil Recommendations, S.R. 252 over Little Cedar Creek, Franklin County", Indiana, Project No. RS-4624(2) prepared for MTS, Inc., by Alt and Witzig, Inc., Indianapolis, Indiana, November 1983.

Appendix A.

Climatological Statistics for Franklin County.

(5)

Average Temperature (°F)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1934	35.7	24.2	38.2	51.8	64.8	76.3	80.6	73.9	68.5	55.8	47.4	31.3	54.0
1935	32.5	34.5	49.5	49.2	58.2	67.6	77.2	75.3	66.0	55.3	43.2	25.4	52.8
1936	22.8	24.9	45.5	47.6	65.0	72.4	81.0	80.4	71.7	55.8	39.4	36.2	53.6
1937	37.4	33.4	37.4	52.6	61.9	71.0	73.1	75.6	64.4	53.4	39.9	30.8	52.6
1938	31.2	41.1	47.2	54.7	61.8	68.8	74.2	74.7	67.2	56.8	44.4	33.9	54.5
1939	34.8	33.4	43.2	48.5	63.2	73.2	73.2	72.0	70.6	55.4	39.1	35.1	53.4
1940	16.6	32.4	39.3	48.6	59.4	71.4	74.4	74.6	63.4	57.4	43.4	38.7	39.7
1941	31.7	29.0	35.6	57.2	63.9	71.8	75.4	74.0	69.6	59.9	43.4	37.6	54.1
1942	29.3	29.2	44.8	55.0	63.0	72.4	75.8	72.2	65.4	55.0	45.8	30.4	53.2
1943	33.2	34.2	38.0	49.8	63.6	76.4	76.6	75.0	63.8	52.8	40.6	30.0	52.8
1944	33.2	35.8	39.5	51.4	68.5	75.2	75.9	75.1	66.4	53.8	43.7	28.2	53.8
1945	24.8	32.2	52.2	54.1	58.3	69.9	73.0	72.0	69.7	52.6	45.0	25.8	52.5
1946	32.2	35.9	52.0	53.7	60.8	71.7	73.8	68.7	65.8	57.2	47.5	37.2	54.8
1947	36.6	24.6	34.4	52.8	59.6	69.6	70.2	78.4	66.6	61.0	40.4	33.0	52.3
1948	22.3	32.8	43.8	56.0	60.2	71.6	75.4	72.3	67.1	50.8	46.2	35.2	52.9
1949	37.6	35.5	40.2	49.6	-	-	-	73.9	-	-	-	-	-
1950	40.2		37.1	47.0	62.7	68.9	72.2	69.9	63.7	57.4	37.3	24.8	-
1951	30.9	29.4	37.3	48.2	63.2	70.5	73.4	72.5	63.6	55.2	35.1	31.3	50.9
1952	35.9	34.8	39.9	50.8	59.9	74.6	76.6	71.2	64.5	47.7	42.9	35.0	52.8
1953	33.4	35.0	41.8	46.6	63.6	73.2	74.0	73.0	65.3	56.1	42.8	31.8	53.1
1954	31.9	38.7	37.6	55.8	55.4	72.6	74.5	72.6	68.1	57.3	41.5	31.8	53.1
1955	28.5	31.3	40.6	55.7	62.1	65.5	77.4	75.2	66.5	53.3	39.0	28.5	52.0
1956	26.6	34.6	38.9	46.6	60.9	70.1	72.7	72.2	62.8	57.6	41.4	39.5	52.0
1957	24.5	36.0	39.4	53.4	61.5	71.5	73.8	72.3	65.8	50.8	41.6	36.5	52.3
1958	27.7	23.5	35.6	50.7	59.0	66.8	72.7	71.5	65.3	53.5	43.9	23.2	49.4
1959	25.8	32.3	37.6	51.9	65.1	68.8	73.4	76.3	68.2	-	-	36.3	-
1960	32.2	29.6	26.4	-	59.0	67.4	70.6	73.1	68.6	53.3	43.1	24.1	-
1961	24.1	35.0	44.3	44.9	55.5	66.6	72.1	71.1	68.5	54.8	42.0	30.7	50.8
1962	26.5	30.8	37.2	47.6	67.2	69.1	71.9	70.7	61.6	56.2	41.2	27.0	50.6
1963	20.5	22.4	42.6	52.4	58.5	69.0	71.7	68.6	63.6	58.8	44.8	20.7	54.0
1964	30.3	28.1	45.8	59.5									

Total Precipitation (Inches)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1934	0.95	0.63	2.81	0.83	1.09	3.45	0.77	1.45	3.36	0.12	1.40	1.81	18.67
1935	2.57	0.40	5.36	2.24	5.04	3.02	4.68	2.19	2.36	3.51	2.54	1.52	35.43
1936	1.22	2.47	3.00	3.33	2.41	0.60	1.25	2.93	9.98	7.04	2.97	2.27	39.47
1937	12.68	1.42	0.66	3.95	3.67	3.64	3.05	4.53	5.17	5.92	1.64	3.43	46.76
1938	1.36	2.20	5.63	1.58	7.04	5.32	3.63	1.07	9.85	0.65	4.74	1.14	44.21
1939	3.09	3.52	4.26	5.74	1.01	9.38	4.11	0.83	0.80	2.39	1.18	1.48	37.79
1940	1.51	3.44	2.28	6.23	4.06	3.47	0.88	1.32	1.34	1.64	3.33	2.15	31.65
1941	1.38	0.67	0.70	1.97	2.62	5.30	1.86	3.54	1.20	5.78	1.63	2.57	29.22
1942	1.31	3.61	2.28	1.97	4.33	4.69	1.82	4.39	2.30	0.95	5.33	3.17	36.15
1943	1.27	1.85	6.57	2.79	5.47	2.56	2.93	1.82	1.48	1.65	0.83	1.39	30.61
1944	0.72	3.10	4.37	4.09	2.47	0.78	2.15	3.34	1.46	0.26	2.36	2.32	27.42
1945	1.19	3.98	8.88	3.88	3.91	5.04	1.95	1.96	6.67	1.47	4.48	2.94	46.30
1946	0.98	3.55	3.84	1.53	4.78	2.99	3.36	3.69	0.39	1.94	3.66	2.75	33.46
1947	5.21	0.35	1.71	8.76	6.48	4.89	5.91	5.83	3.66	1.90	2.18	0.83	47.71
1948	2.02	3.18	5.03	4.55	2.76	2.61	5.03	2.13	2.13	2.23	7.81	3.30	42.78
1949	10.87	2.43	4.32	1.42	1.34	6.21	5.75	1.28	3.48	2.72	0.54	-	-
1950	10.47	5.44	3.25	3.72	3.21	4.62	2.27	3.51	5.91	1.39	4.98	2.79	51.56
1951	4.25	3.45	4.18	2.85	2.16	4.35	2.27	0.62	2.31	1.30	4.08	4.93	36.75
1952	4.68	2.64	4.29	4.31	5.44	3.99	1.98	2.63	3.48	1.07	2.35	3.28	40.14
1953	4.87	1.15	3.01	2.14	4.55	2.74	6.13	3.34	0.85	1.36	0.83	2.10	33.07
1954	3.09	2.29	2.30	3.55	2.16	3.20	5.25	3.60	1.28	5.00	1.39	2.02	36.53
1955	2.01	4.83	4.63	2.84	4.36	3.03	6.60	1.54	8.30	2.89	4.37	0.51	45.91
1956	2.03	4.31	2.71	4.22	6.30	4.70	4.58	2.17	1.27	1.17	1.43	3.37	38.26
1957	2.30	2.65	1.50	6.04	5.72	6.87	3.07	1.74	1.84	2.01	4.67	5.15	43.56
1958	1.03	0.18	1.40	4.81	6.06	6.57	9.68	6.03	3.66	1.44	3.03	0.22	44.11
1959	7.05	2.57	2.20	3.03	3.26	3.52	4.41	0.79	2.60	3.79	2.81	2.41	38.44
1960	1.35	2.22	1.34	1.22	4.46	7.56	3.94	5.31	1.22	1.50	2.27	1.62	34.01
1961	1.43	3.26	6.82	4.53	6.24	2.87	4.21	2.62	1.78	2.99	2.03	3.27	42.05
1962	2.85	3.66	3.11	0.62	4.65	1.48	6.05	2.56	1.31	2.15	1.70	0.97	31.11
1963	1.05	0.49	7.82	3.57	4.28	1.30	3.66	4.87	0.49	0.06	0.91	0.79	29.29
1964	1.65	1.24	16.47	3.41									

STATION HISTORY

This study of local climate is possible because a citizen of the community for many years generously donated a few minutes a day, seven days a week, reading and recording weather information from government instruments. The present observer is John N. Senefeld. His weather station has been located one mile south of the Brookville post office since December 1, 1937. Earlier observers, dates of service, and direction of station from the nearest post office are: John Shirk and Amos Butler, July 1882 to January 1897; William C. Reifel, May 1, 1925 to February 29, 1936, 3/4 mile southwest of post office; E. R. Livingston, March 1, 1936 to August 31, 1937, 1 mile from post office; and Harry C. Miller, September 1, 1937 to November 30, 1937, 1/2 mile south-southeast of post office.

EXTREMES AND DATES OF OCCURRENCE (1925-1963)

Month	Highest Temperature		Lowest Temperature		Greatest Daily Precipitation		Greatest Monthly Snowfall	
Jan.	79	1/24/43	-25	1/29/63	3.08	1/5/49	11.2	1929
Feb.	77	2/10/32	-22	2/3/51	2.12	2/26/29	12.0	1961
Mar.	86	3/24/29	-6	3/8/43	2.98	3/19/43	12.0	1959
Apr.	89	4/26/48	18	4/14/40	2.67	4/4/57	1.0	1956
May	95	5/31/34	26	5/2/63	4.03	5/8/61	T	1954
June	104	6/28/44	37	6/5/54	2.72	6/28/32		
July	108	7/14/36	45	7/23/47	3.59	7/1/29		
Aug.	105	8/19/36	40	8/31/34	4.05	8/10/31		
Sept.	104	9/1/51	23	9/26/28	4.58	9/2/36		
Oct.	92	10/5/51	15	10/22/52	2.68	10/3/37	0.9	1925
Nov.	86	11/1/50	-7	11/30/58	3.15	11/18/38	9.0	1958
Dec.	74	12/12/31	-19	12/16/32	2.05	12/25/45	14.3	1942

PROBABILITY OF LOW TEMPERATURES IN SPRING AND FALL

Minimum Temp.	Percent of occurrence after the date in spring					Percent of occurrence before the date in fall				
	90%	75%	50%	25%	10%	10%	25%	50%	75%	90%
40	5/11	5/18	5/26	6/3	6/10	9/8	9/14	9/21	9/28	10/4
36	5/1	5/8	5/16	5/24	5/31	9/16	9/22	9/28	10/4	10/10
32	4/17	4/24	5/2	5/10	5/17	9/24	9/30	10/6	10/12	10/18
28	4/9	4/15	4/22	4/29	5/5	10/3	10/11	10/19	10/27	11/4
24	3/20	3/28	4/7	4/17	4/25	10/13	10/22	11/1	11/11	11/20
20	2/27	3/9	3/19	3/29	4/8	10/24	10/31	11/8	11/16	11/23
16	2/21	2/28	3/8	3/16	3/23	10/31	11/11	11/24	12/7	12/18

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU
IN COOPERATION WITH PURDUE AGRICULTURAL EXPERIMENT STATION
CLIMATOGRAPHY OF THE UNITED STATES NO. 20 - 12

LATITUDE 39° 25' N.
LONGITUDE 85° 01' W.
ELEV (GROUND) 600 Ft.

CLIMATOLOGICAL SUMMARY

STATION BROOKVILLE, INDIANA

MEANS AND EXTREMES FOR PERIOD 1934-1963

Month	Temperature (°F) Means: Daily maximum	Means: Daily minimum	Means: Monthly	Extremes: Record highest	Year	Record lowest	Year	Mean degree days **	Precipitation Totals (Inches): Mean	Greatest daily	Year	Snow, Sleet: Mean	Maximum monthly	Year	Greatest daily	Year	Mean number of days: Precip. .10 inch or more	Temperatures Max.: 90° and above	Max.: 32° and below	Min.: 32° and below	Min.: 0° and below	Month
(a)	30	30	30	30		30		30	30	30		30	30		30		9	30	30	30	30	
Jan.	39.7	20.3	30.0	79	1943	-25	1963	1042	3.29	3.08	1949	4.0	11.2	1929	10.0	1951	4	0	7	27	2	Jan.
Feb.	42.4	21.0	32.4	72	1961+	-22	1951	902	2.59	1.76	1945	3.0	12.0	1961	6.0	1951	6	0	5	24	2	Feb.
Mar.	52.2	28.9	40.6	83	1948+	-6	1943	766	3.65	2.98	1943	3.1	12.0	1959	7.0	1959	7	0	2	21	*	Mar.
Apr.	64.0	38.3	51.2	89	1948+	18	1940	405	3.43	2.67	1957	T	1.0	1956+	1.0	1956+	7	0	0	9	0	Apr.
May	74.9	48.1	61.5	95	1934	26	1963	161	4.19	4.03	1961	T	T	1954	T	1954	8	1	0	1	0	May
June	83.6	58.1	70.9	104	1944	37	1954	33	4.01	2.53	1947	0	0		0		7	7	0	0	0	June
July	87.3	61.4	74.4	108	1936	45	1947+	6	3.73	3.35	1953	0	0		0		9	11	0	0	0	July
Aug.	86.5	60.1	73.3	105	1936	40	1934	0	2.73	3.34	1960	0	0		0		5	10	0	0	0	Aug.
Sept.	81.1	51.7	66.4	104	1951	25	1942	84	3.23	4.58	1936	0	0		0		5	5	0	1	0	Sept.
Oct.	70.1	40.1	55.0	92	1951	15	1952	329	2.35	2.68	1937	T	0.4	1959	0.4	1959	6	*	0	7	0	Oct.
Nov.	52.0	30.8	41.4	86	1950	-7	1958	678	2.79	3.15	1938	1.6	9.0	1958	7.5	1958	6	0	1	18	*	Nov.
Dec.	42.0	21.5	31.8	71	1956	-16	1960	1004	2.50	2.05	1943	3.6	14.3	1942	6.6	1943	4	0	7	26	2	Dec.
Year	64.4	40.4	52.4	108	July 1936	-25	Jan. 1963	5410	38.49	4.58	Sept. 1936	15.3	14.3	Dec. 1942	10.0	Jan. 1951	74	34	22	134	6	Year

(a) Average length of record, years.

T Trace, an amount too small to measure.

** Base 65°F

\+ Also on earlier dates, months, or years.

* Less than one half.

CLIMATE OF BROOKVILLE, INDIANA

Brookville, located in Franklin County in Southeast Indiana, has an invigorating climate because of the frequent changes of the weather. Pleasant, cloudless days are interspersed with some rainy days throughout the year. Monsoon rains are unknown but rainfall is usually adequate in all seasons favoring a diversified agriculture. In the summer when moisture utilization is high, a dry month of below normal rainfall affects lawns, pastures, and crops.

Weather changes every few days come from the passing of weather fronts and associated centers of low and high air pressure. In general, a high brings lower temperatures, lower humidity and sunny days. An approaching low brings increasing temperatures, increasing southerly wind, higher humidity, and commencement of rain or showers. This activity is greatest in the spring and least in late summer and early fall.

Precipitation is rather evenly distributed throughout the year, a happy contrast to some areas of the United States that have a "dry season" and require irrigation to maintain green vegetation. The table of monthly rainfall for past years in this report shows the variation of rainfall that may be expected. There is a tendency for spring and early summer rains to exceed winter precipitation. The spring rains are very reliable insuring near maximum soil moisture going into summer when evaporation losses exceed rainfall and dry soils become more probable. A severe drought has never been experienced. About one-third of the annual rainfall flows into streams and out of the area. Future needs may require conservation of this water.

The probability for unusually heavy rains in just a few hours is indicated by a weather study of the area:

Frequency in 100 years	Rain in 1 hour	6 hours	12 hours
4	2.4	4.0	4.6
10	2.1	3.3	3.8
20	1.7	2.8	3.2

Snowfall has varied reception. None occurs in the summer. Some winters have much snow and others have very little. An occasional snow storm may hamper travel and clog roads but at the same time the snow blanket protects winter grains from the very cold air that invariably follows. Heaviest snow storms are those out of the southwest. As they swirl northeastward, abundant moisture flows in from the Gulf of Mexico. A storm out of the northwest, with an inward flow of colder, drier air, leaves less snow. Some mid-winters are thus cold but snowfall is normal or less.

Relative humidity is not measured at this station but estimates are possible from the climatology of the area. Relative humidity varies on sunny summer days from a percent in the 40's in the early afternoon to the 90's about sunrise. Relative humidity rises and falls much as temperature does during a typical day but the highest percent usually occurs with the minimum temperature and the lowest percent with the maximum temperature. A cold front is next in importance in changing relative humidity downward.

Winds blow most frequently from the southwest, however, in one or two of the winter months, prevailing winds are northwest. Damaging winds have three sources. In the order of diminishing area coverage but increasing intensity, they are: lows passing through the region, thunderstorms, and tornadoes. Only 2 tornadoes have been reported in the county since 1916. Neither were of sufficient size to injure people or damage property. Thunderstorms, including incidences of lightning and thunder, occur about 48 days of the year. Most of these occur in the spring and early summer. They are seldom so severe as to cause loss of life, property, or crops. Death dealing smog and fog is unknown.

Heating degree days in the above table provide a comparative number for calculating heating requirements between different places and different times. Fuel consumption for heating is proportional to degree day totals, so a month with twice the heating degree days of another month requires twice as much fuel for heating. Degree days for a single day are obtained by subtracting the mean temperature from 65 degrees.

The growing season (defined here as the number of days between the last spring and first fall temperature of 32°) averages 157 days in length. The season is 176 days or more in 10% of the years, 167 days or more in 25% of the years, less than 147 days in 25% of the years, and less than 138 days in 10% of the years.

Many days of the year are nearly ideal in temperature. A few days in the summer when temperatures exceed 90, or decline below zero in the winter, tend to obscure this fact. The fall season is considered by many as the best time of year for outdoor activities. Spring is also a favorite season but actually this season has more days of rain and thunderstorms. In the fall the atmosphere in total seems more quiet. Air and soil temperatures are nearer in agreement than any other time of the year, thus, convective activity is diminished. Many days are sunny and showers are less frequent.

Lawrence A. Schaal
Weather Bureau State Climatologist
Purdue University, Agronomy Department
Lafayette, Indiana

Appendix B.

Statistical Stream Flow Data.

GREAT MIAMI RIVER BASIN

03276500 Whitewater River at Brookville, Ind.

LOCATION.--Lat 39°24'24", long 85°00'46", in NE¼NW¼ sec.32, T.9 N., R.2 W., Franklin County, on right bank at downstream side of highway bridge, 0.3 mile (0.5 km) downstream from East Fork Whitewater River, and 1.1 miles (1.8 km) south of Brookville.

DRAINAGE AREA.--1,224 mi² (3,170 km²).

DURATION TABLE OF DAILY DISCHARGE FOR YEAR ENDING SEPTEMBER 30

NUMBER OF DAYS IN CLASS

CLASS / YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	CFS_DAYS
1916							15	12	21	32	33	22	22	21	19	30	21	32	23	23	5	11	8	3	5		1	3	2	1			1			624876.0
1917							46	66	32	11	24	18	23	32	18	19	16	12	10	10	6	8	5	1	1	2	1	2	1	1						410859.0
1924							1	39	47	37	10	6	4	10	22	30	31	24	36	25	13	5	8	6	5	2	1	2	1	1						607259.0
1925					11	7	49	46	45	60	29	29	20	18	12	8	5	4	6	8	3	1	2													202438.0
1926						1	11	9	11	15	22	18	33	30	29	21	28	30	24	24	15	14	7	3	6	4	4	6								695797.0
1927					19	17	27	11	4	6	5	8	19	43	40	22	23	26	20	17	15	8	11	6	6	7	1	3		1						845128.0
1928						4	21	9	35	14	23	12	20	25	49	35	33	27	11	14	11	9	3	5		2			2	1		1				526848.0
1929							14	30	52	22	24	21	17	10	19	11	23	29	19	24	16	9	8	3	4		2	2	1	1	2	1		1		674350.0
1930			1	29	29	10	16	28	17	20	19	21	15	10	15	22	26	23	9	10	9	3	2	3	1	3		3		1	2	2				504229.0
1931			1	14	89	44	32	23	33	15	25	33	14	9	10	8	4	2	2	4	1	1		1												144883.0
1932					4	23	43	31	31	13	11	20	30	29	29	18	20	16	9	11	8	5	5	2	1	4	1	1		1						417973.0
1933							5	22	35	19	19	24	24	13	22	21	32	29	23	22	14	10	7	5	5	3	4	1		3		3				754127.0
1934		10	22	29	22	11	33	65	38	22	36	31	14	9	5	2	4	2	1	2	1	1	2		1											144661.0
1935			37	65	66	17	10	9	26	22	21	23	14	10	14	7	5	5	3	2	2	4	1	1				1								169764.0
1936		1	8	35	32	14	23	14	20	19	31	17	22	19	23	15	16	14	5	4	3	2	4	2		1	3									287275.0
1937							6	14	12	16	31	36	28	31	46	32	23	24	16	9	10	9	5	4	4	2	1			2	2		2			861518.0
1938							2	3	15	20	29	21	41	35	34	19	33	26	19	16	12	11	8	4	4	5	2	1	4	1						663156.0
1939					8	12	6	41	20	25	34	28	29	20	29	13	23	25	8	9	11	6	4	2	5	2	3	1			1					470933.0
1940			5	23	42	43	50	26	16	18	14	19	23	13	19	12	9	8	5	5	4	2	2	3	1	1		1	1		1					282970.0
1941		7	23	34	33	45	35	46	42	46	23	12	3	3	5	3	1	3		1																99072.0
1942		1	2			8	17	17	25	40	36	44	30	35	31	19	14	11	8	6	6	2	4	3	1	2	1	1	1							369476.0
1943						34	29	14	12	12	29	29	30	32	38	20	24	17	6	8	10	6	3	4	2	1	1		1	1	1	1				478306.0
1944			2	28	32	76	78	16	8	5	6	3	7	13	13	15	22	8	6	7	8	2	2	2	1	1		2	1	1						307276.0
1945				36	62	28	21	14	12	13	17	13	8	13	25	18	14	13	11	10	6	5	10	4	4		2	2	2	1	1					469211.0
1946					16	13	11	11	9	33	33	36	33	26	29	15	25	22	21	5	11	2	5	4	3	1		1								412221.0
1947					17	23	24	3	9	16	29	34	30	18	26	14	24	22	14	13	12	13	8	5	6	3	1	2	1	1		1				584836.0
1948					18	17	15	20	50	64	38	16	8	13	17	17	11	13	11	6	7	7	4	1	3	4	2	2		1	1					434115.0
1949					16	10	8	10	34	16	24	19	27	20	19	30	26	25	16	15	11	10	4	4	3	7	3		3	4				1		710115.0
1950								2	40	34	25	16	14	27	29	21	28	29	22	11	14	10	15	3	3	4	3	6	3	3		2	1			861184.0
1951						21	21	5	13	7	27	25	21	18	37	22	27	21	23	12	18	9	12	7	5	3	4	4		1	1	1				710698.0
1952					14	48	38	20	7	14	13	15	16	18	14	24	20	29	22	7	15	8	5	6	4	1	5		1		1		1			569530.0
1953				3	54	36	14	13	16	24	19	10	24	44	33	20	14	14	7	6	1	6	2	1	3	1										381754.0
1954			21	124	30	21	23	25	30	21	13	10	15	11	7	7	1	3			3															129064.0
1955				21	13	43	37	21	12	15	21	27	31	18	19	16	19	17	4	12	3	4	6	2	2	2										320884.0
1956					21	12	16	7	13	22	30	37	33	26	20	14	25	18	16	19	13	6	8	1	1	1	1	2	3	1						517356.0
1957					43	13	25	32	27	17	11	21	45	23	19	15	15	16	9	7	6	5	2	3	4	1	2	1	1		1	1				426650.0
1958						6	20	6	10	2	6	26	46	43	32	26	31	18	19	15	12	9	12	7	4	3	2	4	3	2	1					734085.0
1959						4	30	20	15	13	34	33	26	24	35	18	33	24	17	12	9	7	3	1	1		2		1		1		1		1	541741.0
1960					19	9	20	25	41	13	18	56	33	40	32	13	12	12	8	3	4	2	2	1	1	1			1							294667.0
1961					34	48	33	19	21	16	23	17	17	19	21	10	13	7	13	8	11	8	9	7	3	2	1		3		1	1				501058.0
1962								46	47	31	27	24	25	38	20	12	23	10	13	10	4	5	2	3	4	2		2	1							415220.0
1963				6	18	9	22	73	68	28	23	13	16	16	11	7	9	10	9	6	3	3	6	3	1	1		1	1	1					1	365930.0
1964				48	98	19	22	27	16	16	24	13	9	5	12	7	12	6	4	6	4	2	5	2	2		2	1	1	2			1			342819.0
1965				11	46	28	27	38	30	14	28	11	20	18	15	13	23	8	9	8	6	8	3	3	1		3	2								340068.0

CLASS	CFS	TOTAL	ACCUM	PERCT	CLASS	CFS	TOTAL	ACCUM	PERCT	CLASS	CFS	TOTAL	ACCUM	PERCT	CLASS	CFS	TOTAL	ACCUM	PERCT
0	0.00	0	16072	100.0	9	310.00	948	10605	66.0	18	2000.0	540	2383	14.8	27	12000	60	175	1.0
1	60.00	19	16072	100.0	10	380.00	1025	9657	60.1	19	2400.0	452	1843	11.5	28	15000	40	115	.7
2	74.00	101	16053	99.9	11	470.00	970	8632	53.7	20	2900.0	356	1391	8.7	29	19000	33	75	.4
3	90.00	403	15952	99.3	12	570.00	976	7662	47.7	21	3600.0	258	1035	6.4	30	23000	17	42	.2
4	110.00	1000	15549	96.7	13	700.00	952	6686	41.6	22	4400.0	224	777	4.8	31	28000	14	25	.1
5	140.00	791	14549	90.5	14	860.00	1023	5734	35.7	23	5500.0	131	553	3.4	32	35000	7	11	.0
6	170.00	994	13758	85.6	15	1100.00	741	4711	29.3	24	6700.0	109	422	2.6	33	42000	2	4	.0
7	210.00	1028	12764	79.4	16	1300.00	847	3970	24.7	25	8200.0	79	313	1.9	34	52000	2	2	.0
8	250.00	1131	11736	73.0	17	1600.00	740	3123	19.4	26	10000.0	59	234	1.5					

LOWEST MEAN DISCHARGE, IN CFS, AND RANKING, FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING MARCH 31

YEAR	1	3	7	14	30	60	90	120	183	ANNUAL
1917	190.00 35	196.00 35	198.00 33	200.00 31	212.00 31	215.00 24	220.00 19	232.00 18	321.00 18	1110.00 21
1925	188.00 33	193.00 33	194.00 31	199.00 30	203.00 28	251.00 28	280.00 26	296.00 25	415.00 24	1060.00 18
1926	113.00 17	116.00 17	125.00 20	132.00 19	203.00 29	301.00 37	350.00 34	388.00 32	441.00 26	1150.00 23
1927	166.00 30	175.00 30	181.00 30	201.00 32	444.00 41	576.00 42	753.00 41	980.00 42	1000.00 42	2140.00 39
1928	110.00 14	112.00 14	123.00 19	133.00 20	148.00 19	186.00 19	252.00 24	325.00 28	474.00 28	1480.00 29
1929	152.00 26	163.00 29	168.00 27	173.00 27	183.00 24	207.00 22	247.00 23	287.00 23	381.00 22	1420.00 26
1930	262.00 37	205.00 36	210.00 35	213.00 33	219.00 33	246.00 27	325.00 31	426.00 36	990.00 40	2200.00 41

WHITEWATER RIVER AT BROOKVILLE, IND.(Continued)

LOWEST MEAN DISCHARGE, IN CFS, AND RANKING, FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING MARCH 31

YEAR	1	3	7	14	30	60	90	120	183	ANNUAL
1931	88.00 6	93.70 8	95.40 8	98.10 8	101.00 7	115.00 6	136.00 7	138.00 7	141.00 3	300.00 2
1932	93.00 10	95.30 9	100.00 10	119.00 14	194.00 26	272.00 32	312.00 28	316.00 27	334.00 19	1080.00 19
1933	119.00 21	124.00 21	136.00 22	148.00 23	182.00 23	254.00 30	366.00 35	423.00 35	579.00 34	1550.00 32
1934	184.00 32	187.00 31	198.00 32	213.00 34	216.00 32	252.00 29	334.00 33	308.00 26	348.00 20	1130.00 22
1935	60.00 1	65.00 2	69.10 2	78.40 2	84.90 1	91.60 1	92.90 1	99.90 1	111.00 1	212.00 1
1936	99.00 12	101.00 12	105.00 12	111.00 12	118.00 10	202.00 21	240.00 22	292.00 24	386.00 23	861.00 13
1937	73.00 3	75.70 3	87.60 4	88.00 4	95.00 3	121.00 8	162.00 13	238.00 19	484.00 30	1670.00 34
1938	190.00 34	195.00 34	210.00 36	263.00 40	401.00 39	500.00 39	532.00 39	573.00 38	699.00 37	1440.00 27
1939	210.00 39	212.00 38	215.00 37	219.00 35	224.00 34	273.00 33	448.00 38	485.00 37	588.00 35	1470.00 28
1940	121.00 22	126.00 22	130.00 21	136.00 21	139.00 18	164.00 17	176.00 18	175.00 12	260.00 13	952.00 15
1941	78.00 4	79.70 4	84.60 3	87.10 3	89.60 2	97.90 2	108.00 2	121.00 4	162.00 6	601.00 4
1942	64.00 2	64.70 1	66.00 1	71.50 1	132.00 15	148.00 15	162.00 14	217.00 16	268.00 14	753.00 5
1943	140.00 25	142.00 25	145.00 24	149.00 24	155.00 21	186.00 20	323.00 30	369.00 31	442.00 27	1170.00 24
1944	128.00 23	141.00 23	148.00 25	150.00 25	159.00 22	175.00 18	174.00 17	195.00 14	210.00 10	851.00 12
1945	80.00 5	84.30 5	89.00 5	97.10 6	97.70 4	103.00 3	111.00 3	116.00 3	127.00 2	1080.00 20
1946	158.00 28	161.00 27	168.00 28	181.00 29	211.00 30	285.00 36	403.00 36	590.00 39	650.00 36	1500.00 30
1947	116.00 18	117.00 18	120.00 17	123.00 15	126.00 12	138.00 12	151.00 12	183.00 13	286.00 15	796.00 9
1948	208.00 38	216.00 40	224.00 40	236.00 38	259.00 37	281.00 35	301.00 27	338.00 29	577.00 33	1810.00 36
1949	110.00 15	117.00 19	120.00 18	125.00 16	134.00 16	146.00 14	164.00 15	230.00 17	364.00 21	2080.00 38
1950	178.00 31	187.00 32	204.00 34	256.00 39	282.00 38	375.00 38	406.00 37	410.00 34	530.00 31	2050.00 37
1951	299.00 41	291.00 41	313.00 41	331.00 41	406.00 40	553.00 40	776.00 42	836.00 41	978.00 39	2160.00 40
1952	132.00 24	141.00 24	144.00 23	147.00 22	150.00 20	162.00 16	173.00 16	217.00 15	433.00 25	1670.00 35
1953	112.00 16	113.00 15	117.00 15	126.00 18	136.00 17	144.00 13	149.00 11	166.00 11	239.00 12	887.00 10
1954	101.00 13	102.00 13	105.00 13	110.00 11	114.00 9	117.00 7	120.00 6	127.00 6	156.00 5	530.00 3
1955	90.00 7	92.00 6	92.00 6	93.10 5	98.50 5	130.00 10	144.00 10	151.00 9	178.00 7	781.00 8
1956	91.00 8	96.70 10	99.10 9	103.00 9	131.00 14	210.00 23	327.00 32	405.00 33	539.00 32	1230.00 25
1957	116.00 19	116.00 16	117.00 14	118.00 13	123.00 11	129.00 9	142.00 9	156.00 10	234.00 11	779.00 7
1958	160.00 29	162.00 28	164.00 26	171.00 26	201.00 27	223.00 26	230.00 20	282.00 22	742.00 38	1510.00 31
1959	400.00 42	410.00 42	421.00 42	449.00 42	469.00 42	567.00 41	680.00 40	720.00 40	1350.00 41	2500.00 42
1960	156.00 27	159.00 26	174.00 29	178.00 28	192.00 25	217.00 25	240.00 21	254.00 20	312.00 17	807.00 11
1961	118.00 20	119.00 20	120.00 16	125.00 17	128.00 13	131.00 11	141.00 8	146.00 8	184.00 9	898.00 14
1962	211.00 40	212.00 39	217.00 38	220.00 36	239.00 36	274.00 34	322.00 29	354.00 30	479.00 29	1660.00 33
1963	200.00 36	209.00 37	218.00 39	221.00 37	229.00 35	261.00 31	261.00 25	268.00 21	294.00 16	972.00 16
1964	92.00 9	92.00 7	94.70 7	97.40 7	101.00 6	108.00 4	113.00 4	113.00 2	144.00 4	759.00 6
1965	98.00 11	99.30 11	101.00 11	103.00 10	108.00 8	112.00 5	118.00 5	126.00 5	181.00 8	1000.00 17

HIGHEST MEAN DISCHARGE, IN CFS, AND RANKING, FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING SEPTEMBER 30

YEAR	1	3	7	15	30	60	90	120	183	ANNUAL
1916	38700.0 7	25100.0 8	14300.0 9	8490.0 9	6390.0 6	4950.0 8	3930.0 9	3490.0 8	2870.0 6	1710.0 11
1917	19400.0 29	14500.0 25	8270.0 25	5210.0 29	3960.0 27	2600.0 30	2340.0 31	2090.0 31	1890.0 25	1130.0 28
1924	20900.0 27	11800.0 29	6710.0 32	4590.0 32	4150.0 25	3030.0 27	3070.0 22	2800.0 17	2690.0 10	1660.0 12
1925	4720.0 42	3290.0 42	2970.0 40	2200.0 40	1590.0 40	1110.0 40	926.0 40	873.0 40	737.0 40	555.0 39
1926	14500.0 33	10000.0 31	8140.0 26	6020.0 23	4470.0 22	3320.0 23	2630.0 29	2260.0 28	2190.0 18	1910.0 6
1927	22900.0 23	14700.0 24	8550.0 24	5760.0 25	4920.0 17	3590.0 19	3610.0 13	3210.0 14	2600.0 13	1770.0 10
1928	28400.0 17	12100.0 28	7210.0 29	5470.0 27	3680.0 31	2530.0 32	2690.0 27	2340.0 26	2070.0 23	1440.0 16
1929	46600.0 4	21700.0 12	11100.0 16	7160.0 14	4510.0 20	3860.0 18	3530.0 14	3260.0 12	3270.0 5	1850.0 7
1930	28500.0 16	26500.0 5	20800.0 1	12600.0 3	7740.0 4	4990.0 6	4170.0 6	3450.0 10	2520.0 14	1380.0 18
1931	6080.0 41	4020.0 41	2700.0 42	2140.0 41	1480.0 41	1080.0 41	857.0 41	753.0 42	614.0 41	397.0 41
1932	21400.0 26	8680.0 34	6930.0 30	5540.0 26	3960.0 26	3120.0 26	2470.0 30	2310.0 27	1780.0 27	1140.0 26
1933	34500.0 10	22100.0 9	13400.0 10	7990.0 11	5710.0 12	5240.0 4	4390.0 3	3940.0 3	3480.0 2	2070.0 2
1934	7090.0 40	4380.0 40	2760.0 41	1710.0 42	1350.0 43	993.0 42	755.0 43	755.0 41	607.0 42	396.0 42
1935	12600.0 35	6780.0 37	5060.0 36	3530.0 37	2190.0 39	1420.0 39	1180.0 39	1010.0 39	814.0 39	465.0 40
1936	11200.0 37	9450.0 33	5680.0 34	3810.0 35	2590.0 36	2490.0 35	2050.0 36	1680.0 36	1290.0 37	785.0 37
1937	41800.0 5	25400.0 7	18500.0 2	15700.0 1	9810.0 1	6030.0 2	4370.0 4	3660.0 5	2790.0 9	1810.0 9
1938	20600.0 28	15200.0 22	9860.0 22	6320.0 20	6170.0 9	4540.0 11	3510.0 15	3170.0 15	2680.0 11	1820.0 8
1939	27300.0 19	17100.0 19	10100.0 20	6030.0 22	3900.0 28	3480.0 21	3200.0 19	2630.0 19	2110.0 20	1290.0 22
1940	25200.0 22	18000.0 15	10500.0 18	5970.0 24	3580.0 32	2280.0 36	2110.0 35	1820.0 35	1390.0 35	773.0 38
1941	2500.0 44	1710.0 44	1290.0 44	1020.0 44	671.0 44	452.0 44	381.0 44	363.0 44	372.0 44	271.0 44
1942	17700.0 31	11300.0 30	6710.0 31	4920.0 31	2970.0 34	2500.0 33	2260.0 33	1940.0 33	1550.0 32	1010.0 29
1943	30600.0 11	21800.0 11	16200.0 3	8770.0 7	4960.0 16	3170.0 25	2930.0 23	2490.0 22	2090.0 21	1310.0 20
1944	21700.0 25	18000.0 16	12000.0 12	6840.0 17	4490.0 21	3390.0 22	2600.0 28	2190.0 30	1520.0 33	840.0 34
1945	27400.0 18	16400.0 20	10200.0 19	6240.0 21	5060.0 15	4140.0 15	3220.0 17	3060.0 16	2300.0 17	1290.0 21
1946	14400.0 34	7720.0 35	5010.0 38	3380.0 38	2650.0 35	2500.0 34	2290.0 32	2010.0 32	1760.0 28	1130.0 27
1947	29900.0 13	19000.0 13	11300.0 15	7010.0 15	5600.0 13	4920.0 9	3940.0 8	3260.0 13	2650.0 12	1600.0 13
1948	26700.0 20	13600.0 26	8800.0 23	6570.0 19	5900.0 11	3950.0 17	3390.0 16	2750.0 18	2090.0 22	1190.0 23
1949	49000.0 3	31000.0 2	15700.0 6	9640.0 5	8710.0 3	5960.0 3	4980.0 2	4270.0 2	3300.0 4	1950.0 4
1950	38700.0 8	26100.0 6	15900.0 5	13000.0 2	9650.0 2	7830.0 1	6080.0 1	5300.0 1	3980.0 1	2360.0 1
1951	29400.0 14	17200.0 18	9970.0 21	7460.0 13	4800.0 18	4200.0 14	3790.0 11	3660.0 6	3310.0 3	1950.0 5
1952	40800.0 6	27300.0 4	14500.0 8	9680.0 4	5950.0 10	4350.0 13	3770.0 12	3470.0 9	2820.0 8	1560.0 14
1953	9240.0 38	6550.0 39	5020.0 37	3610.0 36	2260.0 37	1600.0 37	1700.0 37	1520.0 37	1390.0 36	827.0 35
1954	3340.0 43	2930.0 43	2020.0 43	1680.0 43	1400.0 42	993.0 43	800.0 42	700.0 43	568.0 43	354.0 43
1955	8480.0 39	6720.0 38	5320.0 35	4370.0 33	3400.0 33	2550.0 31	2130.0 34	1870.0 34	1450.0 34	879.0 33
1956	22600.0 24	14800.0 23	7950.0 27	5130.0 30	3820.0 29	3250.0 24	2790.0 24	2450.0 24	2120.0 19	1410.0 17
1957	28600.0 15	17800.0 17	11400.0 14	6810.0 18	4230.0 24	3490.0 20	3090.0 21	2590.0 20	2060.0 24	1170.0 24
1958	25900.0 21	15200.0 21	12700.0 11	7810.0 12	5100.0 14	4990.0 5	4110.0 7	3690.0 4	2840.0 7	2010.0 3
1959	55000.0 1	33400.0 1	16100.0 4	8700.0 8	7400.0 5	4970.0 7	3850.0 10	3280.0 11	2500.0 16	1480.0 15
1960	15700.0 32	7440.0 36	4900.0 39	3090.0 39	2190.0 38	1540.0 38	1370.0 38	1230.0 38	1240.0 38	805.0 36
1961	30300.0 12	18800.0 14	10700.0 17	8270.0 10	6230.0 8	4580.0 10	4200.0 5	3510.0 7	2510.0 15	1370.0 19
1962	18290.0 30	13500.0 27	7400.0 28	5340.0 28	4430.0 23	3000.0 28	2750.0 25	2340.0 25	1860.0 26	1140.0 25
1963	52000.0 2	30700.0 3	15100.0 7	9140.0 6	6340.0 7	4110.0 16	3130.0 20	2480.0 23	1760.0 29	1000.0 30
1964	35400.0 9	22000.0 10	11900.0 13	6880.0 16	4720.0 19	4420.0 12	3200.0 18	2500.0 21	1740.0 30	937.0 31
1965	12000.0 36	9850.0 32	6030.0 33	3960.0 34	3740.0 30	2850.0 29	2700.0 26	2240.0 29	1640.0 31	932.0 32

Appendix B-1 (cont.).

WHITEWATER RIVER AT BROOKVILLE, IND. (CONTINUED)

STATISTICS ON NORMAL MONTHLY MEANS(ALL DAYS)

BY ROWS(MEAN,VARIANCE,STANDARD DEVIATION, SKEWNESS, COEFF. OF VARIATION,PERCENTAGE OF AVERAGE FLOW)

OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT
0.3880E+03	0.6659E+03	0.1040E+04	0.2220E+04	0.2007E+04	0.2373E+04	0.2205E+04	0.1434E+04	0.1192E+04	0.6086E+03	0.4286E+03	0.4334E+03
0.2137E+06	0.5764E+06	0.4042E+06	0.6332E+07	0.1740E+07	0.1788E+07	0.1487E+07	0.1091E+07	0.1104E+07	0.4459E+06	0.2699E+06	0.4241E+06
0.4623E+03	0.7595E+03	0.9534E+03	0.2516E+04	0.1319E+04	0.1330E+04	0.1219E+04	0.1045E+04	0.1051E+04	0.6677E+03	0.5196E+03	0.6512E+03
0.3683E+01	0.2137E+01	0.1221E+01	0.1644E+01	0.7671E+00	0.4197E+00	0.3270E+00	0.1561E+01	0.1673E+01	0.3134E+01	0.3861E+01	0.5004E+01
0.1191E+01	0.1141E+01	0.9164E+00	0.1134E+01	0.6571E+00	0.5602E+00	0.5530E+00	0.7264E+00	0.8817E+00	0.9729E+00	0.1218E+01	0.1502E+01
0.2574E+01	0.4417E+01	0.6494E+01	0.1472E+02	0.1332E+02	0.1574E+02	0.1462E+02	0.9534E+01	0.7906E+01	0.4553E+01	0.2830E+01	0.2875E+01

STATISTICS ON NORMAL ANNUAL MEANS(ALL DAYS)

MEAN	VARIANCE	STANDARD DEVIATION	SKEWNESS	COEFF. OF VARIATION	SERIAL CORR
0.1252E+04	0.2729E+06	0.5220E+03	-0.1455E-01	0.4168E+00	0.2616E+00

STATISTICS ON LOG MONTHLY MEANS(ALL DAYS)

BY ROWS(MEAN,VARIANCE,STANDARD DEVIATION, SKEWNESS, COEFF. OF VARIATION,PERCENTAGE OF AVERAGE FLOW)

OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT
0.2429E+01	0.2614E+01	0.2822E+01	0.3074E+01	0.3149E+01	0.3295E+01	0.3263E+01	0.3054E+01	0.2934E+01	0.2710E+01	0.2449E+01	0.2462E+01
0.1167E+00	0.1687E+00	0.1953E+00	0.2659E+00	0.1606E+00	0.8447E-01	0.8407E-01	0.9435E-01	0.1194E+00	0.1044E+00	0.8716E-01	0.1153E+00
0.3416E+00	0.4107E+00	0.4419E+00	0.5157E+00	0.4008E+00	0.2904E+00	0.2900E+00	0.3077E+00	0.3461E+00	0.3230E+00	0.2952E+00	0.3396E+00
0.4024E+00	0.5136E+00	-0.1665E+00	0.4129E-02	-0.1029E+01	-0.7626E+00	-0.7023E+00	-0.1734E+00	0.1872E+00	0.2491E+00	0.1376E+01	0.1076E+01
0.1407E+00	0.1564E+00	0.1566E+00	0.1677E+00	0.1269E+00	0.8821E-01	0.8887E-01	0.1009E+00	0.1178E+00	0.1192E+00	0.1183E+00	0.1379E+00
0.7074E+01	0.7626E+01	0.8227E+01	0.8954E+01	0.9230E+01	0.9597E+01	0.9503E+01	0.8901E+01	0.8541E+01	0.7493E+01	0.7204E+01	0.7171E+01

STATISTICS ON LOG ANNUAL MEANS(ALL DAYS)

MEAN	VARIANCE	STANDARD DEVIATION	SKEWNESS	COEFF. OF VARIATION	SERIAL CORR
0.3050E+01	0.5029E-01	0.2243E+00	-0.1034E+01	0.7353E-01	0.2273E+00

ANNUAL PEAKS

1916	40100	1938	23400	1957	35300
1917	28300	1939	30400	1958	28600
1918	17100	1940	36100	1959	81000
1919	35700	1941	3030	1960	20400
1920	45700	1942	30400	1961	42000
1924	25500	1943	52000	1962	26500
1925	9250	1944	20000	1963	64500
1926	21600	1945	30000	1964	46000
1927	20200	1946	21100	1965	22000
1928	28400	1947	30600	1966	13800
1929	68200	1948	37000	1967	23400
1930	30700	1949	61200	1968	57000
1931	11600	1950	45200	1969	31400
1932	24700	1951	33600	1970	37000
1933	30000	1952	61200	1971	29000
1934	13200	1953	13500	1972	17000
1935	18200	1954	4080	1973	17500
1936	17000	1955	12100		
1937	52200	1956	35000		

Appendix B-1 (cont.).

GREAT MIAMI RIVER BASIN

03276000 East Fork Whitewater River at Brookville, Ind.

LOCATION.--Lat 39°24'02", long 85°00'12", in NE¼NE¼ sec.20, T.9 N., R.2 W., Franklin County, on right bank 100 ft (30 m) upstream from bridge on State Highway 101, at Brookville, 0.4 mile (0.6 km) downstream from Brookville Lake, and 1.8 miles (2.9 km) upstream from mouth.

DRAINAGE AREA.--380 mi² (984 km²).

REMARKS.--Flow regulated by Brookville Lake since January 1974.

DURATION TABLE OF DAILY DISCHARGE FOR YEAR ENDING SEPTEMBER 30

NUMBER OF DAYS IN CLASS

CLASS / YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	CFS_DAYS
1955		9	13	7	30	36	38	13	20	15	25	23	20	25	14	18	21	13	5	3	7	2	2	2	2	2										88420.0
1956					23	18	20	11	12	26	38	40	20	15	18	27	22	20	17	13	11	11	3	1		3	2	2			1					153868.0
1957				5	19	30	42	12	24	19	20	32	36	24	22	20	13	7	11	6	4	5	2	4	2		2	1	1	1	1					126539.0
1958						2	19	10	4	7	13	27	42	40	30	39	23	25	16	14	11	13	5	7	2	3	5	2	3	2	1					230031.0
1959				1	12	14	12	22	17	20	35	35	20	23	26	30	16	25	20	14	5	6	4	1		1	1	2				2			1	173615.0
1960			3	9	18	17	20	22	37	6	34	56	37	32	24	17	10	4	6	8	2		1	1	1		1									79233.0
1961				1	26	47	48	20	24	16	18	22	19	17	10	12	12	16	10	8	9	7	8	5	4	1	2		1		2					145085.0
1962						1	26	30	27	27	22	28	33	36	24	18	22	20	10	9	4	4	3	2	2	3	2	1		1						131379.0
1963				21	11	19	56	42	31	18	22	23	9	19	6	10	9	11	13	7	3	4	1	4	1	2			1	1				1		113238.0
1964		8	6	49	77	30	20	30	18	10	15	19	6	10	6	15	7	6	7	6	3	5	2	3	1	2	1	1		2		1				102742.0
1965		2	18	29	34	30	39	28	16	15	27	13	6	11	14	14	21	14	6	10	10	5	2	5	1	1	1	2								106855.0

CLASS	CFS	TOTAL	ACCUM	PERCT	CLASS	CFS	TOTAL	ACCUM	PERCT	CLASS	CFS	TOTAL	ACCUM	PERCT	CLASS	CFS	TOTAL	ACCUM	PERCT
0	0.00	0	4018	100.0	9	93.00	179	2522	62.8	18	630.0	121	503	12.5	27	4200	11	34	.8
1	17.00	19	4018	100.0	10	110.00	269	2343	58.3	19	770.0	98	382	9.5	28	5200	6	23	.5
2	21.00	40	3999	99.5	11	140.00	318	2074	51.6	20	960.0	69	284	7.1	29	6400	7	17	.4
3	26.00	113	3959	98.5	12	180.00	248	1756	43.7	21	1200.0	62	215	5.4	30	8000	5	10	.2
4	32.00	250	3846	95.7	13	220.00	254	1508	37.5	22	1500.0	33	153	3.8	31	9800	3	5	.1
5	40.00	236	3596	89.5	14	270.00	194	1254	31.2	23	1800.0	35	120	3.0	32	12000		2	.0
6	49.00	340	3360	83.6	15	330.00	220	1060	26.4	24	2200.0	16	85	2.1	33	15000	1	2	.0
7	61.00	268	3020	75.2	16	410.00	176	840	20.9	25	2800.0	18	69	1.7	34	19000	1	1	.0
8	75.00	230	2752	68.5	17	510.00	161	664	16.5	26	3400.0	17	51	1.3					

LOWEST MEAN DISCHARGE, IN CFS, AND RANKING, FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING MARCH 31

YEAR	1		3		7		14		30		60		90		120		183		ANNUAL	
1955	20.00	3	20.30	3	21.30	3	21.60	2	22.80	1	32.20	3	36.30	3	40.60	3	48.00	3	256.00	1
1956	19.00	2	19.00	2	19.40	2	21.70	3	31.40	4	48.30	6	102.00	10	119.00	10	148.00	9	367.00	8
1957	30.00	6	30.70	6	31.10	6	32.00	6	36.00	6	38.20	5	42.90	5	45.80	5	68.80	5	237.00	3
1958	38.00	8	38.70	8	40.00	8	42.70	8	49.40	8	65.00	8	70.30	7	85.70	7	206.00	10	454.00	9
1959	92.00	11	98.00	11	104.00	11	111.00	11	117.00	11	137.00	11	163.00	11	175.00	11	384.00	11	792.00	11
1960	31.00	7	31.70	7	33.60	7	36.10	7	42.30	7	56.20	7	62.20	6	67.50	6	87.40	6	245.00	5
1961	25.00	4	25.30	4	26.30	5	29.10	5	34.10	5	35.60	4	40.40	4	43.40	4	51.20	4	239.00	4
1962	49.00	10	49.30	9	49.70	9	52.90	9	65.50	10	76.10	10	81.60	9	102.00	9	141.00	8	504.00	10
1963	47.00	9	50.00	10	55.40	10	59.40	10	61.60	9	75.10	9	74.60	8	88.60	8	94.60	7	299.00	6
1964	26.00	5	26.00	5	26.00	4	26.30	4	26.70	3	29.20	2	32.10	2	32.90	2	39.90	1	229.00	2
1965	17.00	1	17.70	1	18.60	1	20.00	1	24.50	2	25.50	1	27.80	1	31.30	1	46.50	2	313.00	7

HIGHEST MEAN DISCHARGE, IN CFS, AND RANKING, FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING SEPTEMBER 30

YEAR	1		3		7		15		30		60		90		120		183		ANNUAL	
1955	3150.0	11	2460.0	10	1420.0	11	1200.0	10	990.0	10	745.0	10	609.0	10	511.0	10	395.0	10	242.0	10
1956	8800.0	6	4700.0	8	2475.0	8	1610.0	8	1190.0	9	1010.0	7	858.0	9	743.0	7	647.0	4	420.0	3
1957	8920.0	5	5660.0	4	3560.0	5	2080.0	6	1260.0	7	1050.0	6	909.0	6	753.0	6	608.0	5	347.0	6
1958	8380.0	7	5310.0	6	4300.0	3	2560.0	3	1650.0	4	1590.0	2	1300.0	1	1170.0	1	893.0	1	630.0	1
1959	21600.0	1	11300.0	1	5410.0	1	2990.0	1	2640.0	1	1720.0	1	1300.0	2	1110.0	2	828.0	2	476.0	2
1960	3490.0	10	2200.0	11	1720.0	10	1050.0	11	609.0	11	472.0	11	408.0	11	361.0	11	334.0	11	216.0	11
1961	8940.0	4	5650.0	5	3040.0	6	2300.0	4	1780.0	3	1300.0	4	1190.0	3	1020.0	3	731.0	3	397.0	4
1962	6560.0	8	4740.0	7	2500.0	7	1780.0	7	1450.0	6	971.0	9	870.0	8	740.0	8	586.0	6	360.0	5
1963	16400.0	2	9810.0	2	4760.0	2	2830.0	2	1920.0	2	1300.0	5	987.0	4	782.0	4	551.0	7	310.0	7
1964	9820.0	3	5910.0	3	3580.0	4	2140.0	5	1480.0	5	1320.0	3	961.0	5	757.0	5	526.0	9	281.0	9
1965	4280.0	9	3370.0	9	2010.0	9	1320.0	9	1230.0	8	973.0	8	883.0	7	735.0	9	530.0	8	293.0	8

Appendix B-2 (10).

EAST FORK WHITEWATER AT BROOKVILLE, IND (Continued)

STATISTICS ON NORMAL MONTHLY MEANS(ALL DAYS)

BY ROWS(MEAN,VARIANCE,STANDARD DEVIATION, SKEWNESS, COEFF. OF VARIATION,PERCENTAGE OF AVERAGE FLOW)

OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT
0.7513E+02	0.1747E+03	0.2271E+03	0.3784E+03	0.5942E+03	0.7584E+03	0.7743E+03	0.4817E+03	0.3773E+03	0.2439E+03	0.1422E+03	0.8036E+02
0.2054E+04	0.7384E+05	0.4426E+05	0.1817E+06	0.2019E+06	0.2234E+06	0.1810E+06	0.9307E+05	0.1709E+06	0.8057E+05	0.6794E+05	0.2489E+04
0.4579E+02	0.2718E+03	0.2887E+03	0.4402E+03	0.4494E+03	0.4729E+03	0.4255E+03	0.3051E+03	0.4134E+03	0.2839E+03	0.2607E+03	0.4989E+02
0.1249E+01	0.2025E+01	0.2773E+01	0.2344E+01	0.4427E+00	0.7114E+00	0.3073E+00	0.1010E+01	0.2427E+01	0.2952E+01	0.3244E+01	0.7588E+00
0.6529E+00	0.1555E+01	0.1314E+01	0.1163E+01	0.7529E+00	0.6427E+00	0.5481E+00	0.6209E+00	0.1107E+01	0.1164E+01	0.1833E+01	0.6209E+00
0.1811E+01	0.4015E+01	0.5217E+01	0.8694E+01	0.1379E+02	0.1743E+02	0.1784E+02	0.1124E+02	0.8576E+01	0.5604E+01	0.3267E+01	0.1846E+01

STATISTICS ON NORMAL ANNUAL MEANS(ALL DAYS)

MEAN	VARIANCE	STANDARD DEVIATION	SKEWNESS	COEFF. OF VARIATION	SERIAL CORR
0.3612E+03	0.1304E+05	0.1141E+03	0.1155E+01	0.3248E+00	0.4646E-01

STATISTICS ON LOG MONTHLY MEANS(ALL DAYS)

BY ROWS(MEAN,VARIANCE,STANDARD DEVIATION, SKEWNESS, COEFF. OF VARIATION,PERCENTAGE OF AVERAGE FLOW)

OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT
0.1764E+01	0.1994E+01	0.2174E+01	0.2384E+01	0.2639E+01	0.2822E+01	0.2821E+01	0.2621E+01	0.2409E+01	0.2238E+01	0.1881E+01	0.1824E+01
0.7319E-01	0.1774E+00	0.1826E+00	0.1822E+00	0.1562E+00	0.4544E-01	0.7249E-01	0.6580E-01	0.1337E+00	0.1144E+00	0.1565E+00	0.8087E-01
0.2705E+00	0.4214E+00	0.4270E+00	0.4027E+00	0.3953E+00	0.2927E+00	0.2692E+00	0.2565E+00	0.3656E+00	0.3380E+00	0.3956E+00	0.2844E+00
0.2854E+00	0.1356E+01	0.4473E+00	0.4443E+00	-0.4444E+00	-0.4475E+00	-0.3668E+00	0.3719E+00	0.9224E+00	0.1114E+01	0.2392E+01	-0.4118E-01
0.1530E+00	0.2115E+00	0.1967E+00	0.1688E+00	0.1498E+00	0.1037E+00	0.9545E-01	0.9784E-01	0.1518E+00	0.1514E+00	0.2103E+00	0.1559E+00
0.6419E+01	0.7241E+01	0.7785E+01	0.8474E+01	0.9542E+01	0.1025E+02	0.1024E+02	0.9514E+01	0.8745E+01	0.8124E+01	0.6828E+01	0.6623E+01

STATISTICS ON LOG ANNUAL MEANS(ALL DAYS)

MEAN	VARIANCE	STANDARD DEVIATION	SKEWNESS	COEFF. OF VARIATION	SERIAL CORR
0.2530E+01	0.1792E-01	0.1339E+00	0.4134E+00	0.5274E-01	-0.4336E-01

ANNUAL PEAKS

1954	5500	1964	10900
1955	5140	1965	7340
1956	14100	1966	4400
1957	10800	1967	14000
1958	12000	1968	31600
1959	36100	1969	10500
1960	5170	1970	10400
1961	14700	1971	9800
1962	8840	1972	5000
1963	28000	1973	5200

Appendix B-2 (cont.).

GREAT MIAMI RIVER BASIN

03275000 Whitewater River near Alpine, Ind.

LOCATION.--Lat 39°34'23", long 85°09'27", in SW¼SE¼ sec.14, T.13 N., R.12 E., Fayette County, on right bank 500 ft (152 m) downstream from highway bridge, 3.4 mile (5.5 km) downstream from Wilson Creek, 1.6 miles (2.6 km) northeast of Alpine, and 4.7 miles (7.6 km) upstream from Bear Creek.

DRAINAGE AREA.--529 mi² (1,370 km²).

DURATION TABLE OF DAILY DISCHARGE FOR YEAR ENDING SEPTEMBER 30

NUMBER OF DAYS IN CLASS

YEAR \ CLASS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	CFS_DAYS
1929						1	5	43	37	39	18	26	19	17	21	26	25	28	20	11	8	10	2	5	1				2	1	1	1	1			264479.0
1930					20	39	33	33	13	18	21	23	18	27	19	19	35	11	11	4	1	4	2	2	3	1	2	1	2	3						212765.0
1931		1	8	12	30	74	59	38	27	28	27	16	14	11	4	4	3	2	2		1	1	1													50960.0
1932			2	7	37	25	21	34	18	10	17	33	36	26	24	20	13	4	8	4	2	6	2	1	4	4										157060.0
1933								27	14	36	18	24	27	19	13	36	31	29	27	11	16	8	6	3	4	5			3	2	2					327796.0
1934		15	31	29	14	19	25	72	31	28	34	25	12	4	5	2	5	1	2	2	2	1	1													65007.0
1935			22	99	54	20	21	37	14	20	14	14	11	10	10	9	2	2	4	1	7	2	1			1										79931.0
1936				9	40	33	20	28	14	40	21	22	25	18	13	10	10	26	4	7	6	3	4	1	1	1	2	3								169225.0
1937							2	21	14	29	25	36	26	23	32	47	22	13	18	13	4	7	3	2	9	3			1	2		2	1			312440.0
1938							1	29	6	15	21	18	38	38	33	37	28	18	18	11	23	5	3	4	5	4	6	1	1	2						312121.0
1939							7	16	46	24	30	25	32	26	19	17	35	28	11	16	7	8	2	6	2	7	1	2		1						198250.0
1940				15	35	30	64	59	9	26	12	18	24	10	14	12	8	9	3	4	4	2	2		1		2		1							115725.0
1941		2	6	22	50	57	55	81	45	18	18	4	5	3	2	1	3	1																		42523.0
1942			1	1	1	1	1	16	41	22	47	46	27	48	32	25	15	13	9	4	5	5	6	2	1	7	3		1							162094.0
1943							9	33	27	13	29	26	32	47	48	22	18	12	9	10	6	8	4	2	5	1		1	2		1					195478.0
1944				10	14	36	94	71	8	11		11	12	12	12	21	11	12	7	6	4	2	2	3				3	1	1						148891.0
1945				5	54	52	17	22	8	27	11	20	19	13	31	17	15	12	8	4	7	5	1	5	1	2	3	3			1					192045.0
1946					1	11	16	9	16	21	34	34	40	42	29	25	19	22	16	6	7	6		2	4		1									187640.0
1947					2	19	17	26	7	19	33	27	36	36	24	27	19	15	16	11	11	7	2	4	1	2			1	1	1					239978.0
1948					1	7	21	26	21	94	27	22	29	9	20	13	15	11	10	5	9	4	3		4	5		1	2	1						211368.0
1949					4	2	11	31	13	19	15	27	48	26	18	37	27	30	15	5	12	9	5	4	4	4		2	3	1					1	357495.0
1950						1	1	14	17	38	15	15	29	38	31	38	29	33	23	4	14	9	5	5	4	2	4	5	2	1	2	1				365142.0
1951						13	10	7	21	19	21	24	32	27	27	26	12	25	30	17	23	7	7	7	2	5	3	1	2			1				323412.0
1952						20	43	42	19	22	15	13	16	21	17	24	26	25	24	11	10	5	5	4		3	3				1		1			254458.0
1953					16	19	56	23	19	34	19	16	47	37	21	18	11	8	6	1	3	5	1		4	1										133421.0
1954				11	40	108	30	34	21	41	15	10	11	9	8	9	4		4		4		1													84464.0
1955			2	8	23	40	16	42	14	15	29	38	16	13	13	28	14	10	16	4	6			1												122243.0
1956						25	6	27	6	20	43	39	41	23	16	21	31	19	15	8	7	3	4		1	4		1	1	1						209374.0
1957						39	26	41	18	22	34	21	37	18	16	14	20	14	9	3	2	3	2	4	2		3		1	1						170795.0
1958							8	17	8	10	6	21	55	46	31	39	26	22	16	12	13	6	7	8	2	3	1	4	3			1				314112.0
1959						4	19	26	19	20	27	36	34	13	22	31	31	25	21	10	11	7	3	1	2	1	1			1		1	1			249181.0
1960						3	35	50	71	19	24	59	58	31	14	15	8	6	5		4	1	1		1		1									116490.0
1961					13	59	48	10	16	21	18	23	26	17	17	15	9	9	13	7	10	7	10	6	5	3	3	1	1		1					240901.0
1962								30	34	44	26	38	34	37	26	23	16	18	8	5	6	4	1	4	4	2	1	1								190088.0
1963				2	22	9	22	114	35	37	16	15	15	20	5	9	7	9	8	4	5	4	2	2	2		1		1						1	155905.0
1964				14	67	86	32	38	20	15	17	15	8	13	11	14	5	4	5	4	4	4	3	5	2	1	1		1	1	2					160699.0
1965					19	43	46	53	10	35	24	17	10	21	22	15	8	9	9	1	13	1	2	2		3	1		1							146768.0
1966				3	24	24	20	104	22	34	37	21	22	15	12	9	6	3	3	3	2		1		1											85136.0
1967						20	36	30	8	24	4	26	24	33	20	17	28	16	14	13	16	5	9	4	3	3	2	1	3							261616.0
1968								41	16	2	10	37	43	30	35	28	30	21	21	14	6	9	5	3	3	2	3	3	1			1				242722.0
1969								3	33	14	15	17	50	56	41	35	24	18	14	10	10	6	3	5	3	2	1	2		2	1					270079.0
1970								31	19	20	44	43	42	20	9	30	31	25	6	9	3	5	2	1	3	1		3								194914.0
1971							33	49	58	44	39	30	25	18	17	11	7	4	7	8	2	2	2	1	2	1	1	1	1							144413.0
1972							29	77	12	33	28	9	48	38	26	19	18	6	9	3	8	2	3	3	2	1										154445.0
1973									12	33	12	12	27	40	44	31	42	24	24	10	16	10	8	8	4	3	2	1	2							313302.0

CLASS	CFS	TOTAL	ACCUM	PERCT	CLASS	CFS	TOTAL	ACCUM	PERCT	CLASS	CFS	TOTAL	ACCUM	PERCT	CLASS	CFS	TOTAL	ACCUM	PERCT
0	0.00	0	16436	100.0	9	150.00	1128	10840	66.0	18	960.0	525	1973	12.0	27	6000	41	128	.7
1	30.00	18	16436	100.0	10	190.00	1043	9712	59.1	19	1200.0	284	1448	8.8	28	7400	39	87	.5
2	37.00	72	16418	99.9	11	230.00	1084	8669	52.7	20	1400.0	351	1164	7.1	29	9100	22	48	.2
3	45.00	233	16346	99.5	12	290.00	1294	7585	46.1	21	1800.0	199	813	4.9	30	11000	13	26	.1
4	55.00	587	16113	98.0	13	350.00	1092	6291	38.3	22	2200.0	135	614	3.7	31	14000	8	13	.0
5	68.00	939	15526	94.5	14	430.00	882	5199	31.6	23	2700.0	124	479	2.9	32	17000	3	5	.0
6	83.00	1103	14587	88.8	15	520.00	945	4317	26.3	24	3300.0	101	355	2.2	33	21000		2	.0
7	100.00	1702	13484	82.0	16	640.00	769	3372	20.5	25	4000.0	79	254	1.5	34	25000	2	2	.0
8	120.00	942	11782	71.7	17	780.00	630	2603	15.8	26	4900.0	47	175	1.1					

WHITEWATER RIVER NEAR ALPINE, IND. (Continued)

LOWEST MEAN DISCHARGE, IN CFS, AND RANKING, FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING MARCH 31

YEAR	1	3	7	14	30	60	90	120	183	ANNUAL
1930	95.00 30	99.30 30	93.30 30	95.70 29	102.00 29	124.00 31	156.00 32	198.00 35	459.00 43	987.00 41
1931	54.00 12	57.70 11	59.10 11	61.90 11	65.40 11	72.20 8	74.30 7	75.00 7	77.60 6	143.00 2
1932	36.00 3	37.00 2	41.20 3	51.10 4	63.10 5	79.00 14	117.00 24	126.00 24	130.00 16	404.00 17
1933	59.00 15	61.30 15	63.90 15	68.90 16	80.60 18	100.00 25	166.00 34	196.00 34	234.00 32	439.00 28
1934	85.00 31	85.70 28	89.70 29	102.00 32	109.00 31	136.00 35	164.00 33	159.00 30	175.00 23	506.00 24
1935	30.00 1	32.70 1	33.10 1	40.40 1	45.20 1	47.00 1	48.50 1	48.60 1	51.70 1	88.20 1
1936	47.00 7	59.30 14	65.40 16	66.60 14	72.70 14	99.40 24	119.00 25	145.00 27	188.00 25	477.00 22
1937	49.00 10	52.30 9	55.00 9	57.10 7	66.10 12	75.60 11	81.80 12	98.30 14	217.00 28	821.00 39
1938	97.00 35	104.00 35	105.00 36	122.00 39	149.00 40	194.00 41	214.00 40	224.00 39	314.00 37	850.00 38
1939	94.00 33	110.00 37	111.00 37	114.00 34	120.00 34	133.00 33	215.00 41	211.00 38	263.00 35	662.00 32
1940	71.00 23	78.00 23	81.10 22	81.70 20	82.40 19	91.20 18	96.40 16	94.40 13	133.00 17	406.00 16
1941	48.00 8	49.70 6	51.90 5	55.00 6	57.00 6	57.60 2	61.50 2	67.10 3	81.80 5	244.00 3
1942	33.00 2	38.00 3	39.90 2	43.50 2	64.80 8	73.70 9	81.20 10	105.00 16	117.00 12	336.00 9
1943	80.00 27	81.30 25	82.90 25	84.40 23	86.00 22	98.40 22	134.00 28	162.00 31	186.00 24	459.00 20
1944	70.00 21	75.70 21	81.40 23	85.60 25	88.40 24	104.00 26	102.00 19	107.00 19	114.00 11	394.00 15
1945	48.00 9	49.70 7	62.70 13	63.40 13	64.70 7	66.10 5	67.40 4	69.60 4	70.50 2	446.00 19
1946	110.00 38	111.00 38	115.00 38	118.00 37	134.00 38	169.00 38	213.00 39	349.00 41	340.00 38	670.00 33
1947	67.00 17	69.30 19	71.60 19	73.40 19	77.10 17	87.30 15	93.70 15	106.00 17	156.00 21	364.00 12
1948	127.00 39	138.00 41	140.00 41	146.00 41	165.00 41	169.00 39	174.00 35	167.00 33	262.00 34	777.00 35
1949	65.00 19	74.00 20	78.70 20	81.90 21	85.40 20	93.10 19	104.00 20	135.00 25	219.00 29	939.00 42
1950	74.00 24	100.00 33	110.00 35	116.00 35	131.00 36	182.00 40	195.00 38	200.00 36	225.00 30	883.00 40
1951	145.00 42	146.00 42	153.00 42	158.00 42	215.00 42	291.00 44	378.00 44	383.00 44	434.00 42	942.00 41
1952	78.00 22	82.00 26	88.00 27	89.10 27	92.20 27	99.40 23	104.00 21	124.00 21	225.00 31	773.00 34
1953	76.00 24	78.30 24	81.90 24	83.60 22	85.60 21	89.30 17	92.30 14	95.40 12	127.00 13	344.00 10
1954	58.00 13	58.00 12	60.30 12	62.60 12	65.10 9	67.70 6	70.70 6	71.90 5	81.90 6	252.00 4
1955	46.00 6	46.70 5	48.10 4	49.50 3	53.60 2	71.20 7	75.40 8	78.70 8	92.70 8	328.00 8
1956	42.00 4	43.70 4	54.40 7	59.90 9	68.50 13	87.60 16	131.00 27	157.00 28	206.00 27	508.00 25
1957	66.00 20	66.00 18	70.00 18	71.90 17	73.10 16	77.20 12	81.20 11	87.20 11	103.00 10	260.00 5
1958	93.00 32	94.00 31	95.70 31	98.40 30	113.00 33	131.00 32	135.00 29	158.00 29	379.00 40	446.00 29
1959	210.00 44	215.00 44	227.00 44	240.00 44	243.00 44	290.00 43	351.00 43	363.00 43	617.00 44	1590.00 44
1960	75.00 25	77.00 22	80.70 21	85.00 24	92.10 24	106.00 28	113.00 23	124.00 22	150.00 20	380.00 14
1961	62.60 18	62.00 16	65.70 16	67.40 15	72.90 15	78.50 13	82.10 13	82.60 10	87.20 7	365.00 13
1962	127.00 40	130.00 40	136.00 40	137.00 40	147.00 39	165.00 37	191.00 37	203.00 37	261.00 33	789.00 37
1963	100.00 36	101.00 34	103.00 33	104.00 33	109.00 32	115.00 29	126.00 26	125.00 23	145.00 19	433.00 18
1964	44.00 4	51.30 8	52.40 6	53.20 5	54.40 3	58.50 3	62.00 3	62.30 2	73.00 3	306.00 7
1965	58.00 14	59.00 13	58.70 10	60.00 10	63.30 6	65.90 4	69.40 5	74.10 6	93.80 9	471.00 21
1966	61.00 16	63.30 17	65.70 17	72.70 18	86.10 23	105.00 27	111.00 22	116.00 20	128.00 14	346.00 11
1967	53.00 11	53.70 10	54.60 8	57.60 8	65.10 10	74.90 10	78.50 9	81.20 9	133.00 18	513.00 26
1968	94.00 28	86.70 29	88.90 28	89.60 28	91.10 25	95.50 20	100.00 17	107.00 18	190.00 26	568.00 27
1969	126.00 41	129.00 39	129.00 39	131.00 39	133.00 37	152.00 36	190.00 36	311.00 40	417.00 41	779.00 36
1970	143.00 43	143.00 43	143.00 43	707.00 43	217.00 43	222.00 42	235.00 42	353.00 42	366.00 39	659.00 31
1971	104.00 37	109.00 36	110.00 34	117.00 36	129.00 35	134.00 34	141.00 30	143.00 26	165.00 22	502.00 23
1972	99.00 29	85.30 27	87.00 26	89.00 26	93.90 28	97.20 21	101.00 18	103.00 15	130.00 15	297.00 6
1973	94.00 34	96.70 32	98.00 32	99.10 31	105.00 30	122.00 30	156.00 31	171.00 32	298.00 36	794.00 38

HIGHEST MEAN DISCHARGE, IN CFS, AND RANKING, FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING SEPTEMBER 30

YEAR	1	3	7	15	30	60	90	120	183	ANNUAL
1929	14400.0 4	7810.0 15	4070.0 23	2780.0 22	1940.0 20	1440.0 22	1310.0 19	1210.0 16	1250.0 7	725.0 10
1930	10900.0 20	9450.0 10	7820.0 2	5030.0 3	3200.0 4	2070.0 9	1730.0 7	1420.0 11	1040.0 15	583.0 17
1931	2240.0 44	1660.0 43	1000.0 44	751.0 44	513.0 44	396.0 44	318.0 44	288.0 44	241.0 44	167.0 44
1932	4560.0 37	3880.0 34	2920.0 32	2330.0 27	1600.0 30	1260.0 24	1000.0 32	864.0 32	670.0 34	429.0 35
1933	13400.0 11	9520.0 9	6290.0 9	3680.0 10	2530.0 11	2200.0 5	1840.0 5	1630.0 4	1440.0 3	897.0 2
1934	2440.0 42	1950.0 42	1250.0 42	761.0 43	558.0 43	439.0 43	333.0 43	325.0 43	271.0 43	176.0 43
1935	4470.0 39	2440.0 38	2170.0 38	1630.0 37	1020.0 39	677.0 39	580.0 40	472.0 40	360.0 41	204.0 41
1936	7200.0 32	4730.0 24	4350.0 19	2600.0 24	1850.0 23	1630.0 17	1330.0 17	1070.0 21	787.0 27	462.0 27
1937	17400.0 6	11600.0 5	8440.0 1	7240.0 1	4620.0 1	2940.0 2	2160.0 2	1820.0 2	1340.0 5	857.0 4
1938	10300.0 22	7090.0 20	4340.0 18	3150.0 17	2930.0 6	2110.0 7	1610.0 11	1490.0 9	1220.0 9	855.0 7
1939	10500.0 21	8610.0 25	4060.0 24	2440.0 23	1700.0 27	[illegible]	1320.0 18	1120.0 19	879.0 20	543.0 20
1940	7690.0 30	5450.0 26	3690.0 29	2110.0 32	1310.0 35	88[illegible] 34	798.0 36	705.0 36	547.0 37	316.0 39
1941	916.0 45	755.0 45	585.0 45	413.0 45	273.0 45	186.0 45	156.0 45	149.0 45	147.0 45	117.0 45
1942	8680.0 27	6630.0 32	2990.0 30	2190.0 30	1350.0 34	1140.0 33	1050.0 31	875.0 31	677.0 32	444.0 28
1943	12300.0 13	7470.0 16	5730.0 12	3700.0 15	1840.0 26	1200.0 31	1200.0 26	1070.0 26	842.0 23	534.0 21
1944	9560.0 23	8570.0 11	5650.0 13	3260.0 14	2120.0 19	1610.0 18	1260.0 22	1040.0 24	723.0 30	407.0 33
1945	11000.0 17	7070.0 21	3830.0 27	2730.0 29	1850.0 24	1440.0 21	1170.0 28	1180.0 17	694.0 19	526.0 23
1946	5710.0 34	2430.0 39	2010.0 39	1400.0 38	1110.0 36	1020.0 35	948.0 33	850.0 33	770.0 26	514.0 25
1947	17200.0 14	8220.0 14	5250.0 14	3170.0 16	2440.0 13	2010.0 18	1600.0 12	1320.0 12	1070.0 14	657.0 16
1948	9140.0 26	8270.0 27	4060.0 25	3090.0 18	2720.0 9	1810.0 14	1570.0 13	1290.0 13	994.0 14	574.0 18
1949	25100.0 2	13400.0 1	6960.0 3	4420.0 4	3650.0 3	2530.0 3	2120.0 3	1790.0 3	1420.0 4	843.0 8
1950	16400.0 7	11400.0 6	6490.0 6	5700.0 2	4090.0 2	3310.0 1	2480.0 1	2230.0 1	1650.0 1	1000.0 1
1951	14400.0 8	8300.0 12	4740.0 17	3420.0 13	2310.0 16	1970.0 13	1710.0 8	1640.0 5	1480.0 2	887.0 3
1952	14900.0 3	12500.0 2	6580.0 5	4390.0 5	2660.0 10	1940.0 12	1640.0 10	1550.0 6	1240.0 4	696.0 12
1953	4580.0 38	3210.0 35	2430.0 35	1440.0 36	1110.0 37	737.0 38	771.0 37	684.0 38	602.0 35	367.0 36
1954	2760.0 43	1809.0 44	1110.0 43	949.0 42	802.0 41	524.0 41	411.0 42	352.0 42	281.0 42	176.0 42
1955	3170.0 41	2080.0 41	1410.0 41	1720.0 40	1040.0 38	635.0 37	743.0 38	691.0 37	545.0 38	335.0 37
1956	10900.0 18	6670.0 22	3739.0 28	2259.0 28	1650.0 28	1340.0 25	1100.0 30	962.0 29	844.0 21	572.0 19
1957	10900.0 19	6580.0 26	3490.0 26	2390.0 26	1540.0 32	1230.0 29	1260.0 23	1050.0 26	808.0 25	468.0 26
1958	14000.0 10	7440.0 18	6390.0 7	3870.0 7	2520.0 12	2240.0 4	1750.0 6	1540.0 7	1200.0 10	866.0 6
1959	17000.0 5	12000.0 4	4240.0 16	3730.0 9	3130.0 5	2150.0 6	1670.0 9	1440.0 10	1130.0 13	683.0 13
1960	4980.0 35	2400.0 37	2270.0 37	1370.0 39	981.0 40	674.0 40	614.0 39	535.0 39	475.0 39	318.0 38
1961	12600.0 12	8300.0 13	5190.0 15	3570.0 12	2880.0 7	2090.0 8	1940.0 4	1670.0 4	1200.0 11	660.0 15
1962	6500.0 33	5040.0 31	2810.0 33	2180.0 31	1850.0 25	1340.0 26	1730.0 24	1040.0 25	833.0 24	521.0 24
1963	26300.0 1	12100.0 3	6290.0 8	3940.0 6	2760.0 8	1780.0 15	1300.0 20	1030.0 27	739.0 29	427.0 31
1964	11700.0 16	9930.0 8	5450.0 11	3610.0 11	2410.0 14	1990.0 11	1470.0 14	1160.0 18	866.0 24	439.0 29
1965	8440.0 28	5270.0 30	2470.0 31	1710.0 35	1600.0 29	1190.0 32	1160.0 29	957.0 28	698.0 31	402.0 34
1966	3410.0 40	2500.0 40	1610.0 40	1000.0 41	673.0 42	474.0 42	454.0 41	426.0 41	363.0 40	233.0 40

WHITEWATER RIVER NEAR ALPINE, IND.(Continued)

HIGHEST MEAN DISCHARGE, IN CFS, AND RANKING, FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING SEPTEMBER 30

YEAR		3	7	15	30	60	90	120	183	ANNUAL
1967	9030.0 25	7670.0 17	5070.0 16	3000.0 21	1900.0 21	1500.0 29	1450.0 15	1250.0 14	1190.0 12	717.0 11
1968	16100.0 9	10300.0 7	6730.0 4	3420.0 8	2290.0 18	1410.0 24	1190.0 27	1060.0 22	973.0 17	663.0 14
1969	11900.0 15	7410.0 14	4270.0 20	3090.0 19	2310.0 15	1560.0 19	1260.0 21	1110.0 25	972.0 18	740.0 9
1970	7330.0 31	4200.0 33	2450.0 34	1680.0 36	1570.0 31	1300.0 27	1230.0 25	1050.0 23	852.0 22	534.0 22
1971	8840.0 24	5280.0 29	4140.0 22	2550.0 25	1860.0 22	1220.0 30	913.0 34	829.0 34	654.0 35	397.0 35
1972	4820.0 36	3020.0 36	2470.0 36	2010.0 33	1520.0 33	1070.0 34	688.0 35	799.0 35	673.0 33	423.0 32
1973	7920.0 29	4730.0 23	4240.0 21	3040.0 29	2300.0 17	1760.0 16	1370.0 16	1220.0 15	1270.0 6	858.0 5

STATISTICS ON NORMAL MONTHLY MEANS(ALL DAYS)

BY ROWS(MEAN,VARIANCE,STANDARD DEVIATION, SKEWNESS, COEFF. OF VARIATION,PERCENTAGE OF AVERAGE FLOW)

OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT
0.1564E+03	0.3117E+03	0.4816E+03	0.4494E+03	0.4460E+03	0.9831E+03	0.9614E+03	0.6904E+03	0.4933E+03	0.3251E+03	0.2002E+03	0.1618E+03
0.1430E+05	0.1232E+06	0.2057E+06	0.1099E+07	0.3446E+06	0.3492E+06	0.3222E+06	0.2483E+06	0.1946E+06	0.9718E+05	0.4913E+05	0.1685E+05
0.1196E+03	0.3510E+03	0.4535E+03	0.1048E+04	0.5888E+03	0.5909E+03	0.5676E+03	0.4983E+03	0.4412E+03	0.3117E+03	0.2217E+03	0.1298E+03
0.2226E+01	0.2172E+01	0.1144E+01	0.2050E+01	0.9278E+00	0.5811E+00	0.5805E+00	0.1584E+01	0.2475E+01	0.2523E+01	0.4261E+01	0.2694E+01
0.7643E+00	0.1126E+01	0.9416E+00	0.1256E+01	0.6960E+00	0.6011E+00	0.5904E+00	0.7217E+00	0.8943E+00	0.9590E+00	0.1107E+01	0.8022E+00
0.2414E+01	0.4804E+01	0.7432E+01	0.1342E+02	0.1305E+02	0.1517E+02	0.1484E+02	0.1065E+02	0.7612E+01	0.5016E+01	0.3090E+01	0.2497E+01

STATISTICS ON NORMAL ANNUAL MEANS(ALL DAYS)

MEAN	VARIANCE	STANDARD DEVIATION	SKEWNESS	COEFF. OF VARIATION	SERIAL CORR
0.5304E+03	0.5093E+05	0.2257E+03	0.9403E-01	0.4192E+00	0.3195E+00

STATISTICS ON LOG MONTHLY MEANS(ALL DAYS)

BY ROWS(MEAN,VARIANCE,STANDARD DEVIATION, SKEWNESS, COEFF. OF VARIATION,PERCENTAGE OF AVERAGE FLOW)

OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT
0.2108E+01	0.2307E+01	0.2444E+01	0.2642E+01	0.2795E+01	0.2897E+01	0.2893E+01	0.2737E+01	0.2576E+01	0.2383E+01	0.2182E+01	0.2120E+01
0.4776E-01	0.1454E+00	0.1867E+00	0.2324E+00	0.1495E+00	0.1014E+00	0.9342E-01	0.9794E-01	0.9574E-01	0.1016E+00	0.8192E-01	0.6923E-01
0.2683E+00	0.3813E+00	0.4321E+00	0.4825E+00	0.3867E+00	0.3184E+00	0.3057E+00	0.3130E+00	0.3094E+00	0.3187E+00	0.2862E+00	0.2631E+00
0.7782E+00	0.7265E+00	0.4946E-01	0.1584E+00	-0.4248E+00	-0.7315E+00	-0.6705E+00	-0.3407E+00	0.4075E+00	0.5053E+00	0.1172E+01	0.7638E+00
0.1235E+00	0.1653E+00	0.1738E+00	0.1799E+00	0.1384E+00	0.1099E+00	0.1056E+00	0.1144E+00	0.1201E+00	0.1337E+00	0.1312E+00	0.1241E+00
0.4967E+01	0.7447E+01	0.8242E+01	0.8892E+01	0.9245E+01	0.9604E+01	0.9591E+01	0.9072E+01	0.8538E+01	0.7981E+01	0.7234E+01	0.7027E+01

STATISTICS ON LOG ANNUAL MEANS(ALL DAYS)

MEAN	VARIANCE	STANDARD DEVIATION	SKEWNESS	COEFF. OF VARIATION	SERIAL CORR
0.2685E+01	0.4813E-01	0.2194E+00	-0.9486E+00	0.8173E-01	0.2678E+00

ANNUAL PEAKS

1929	29400	1940	8530	1951	21400	1963	35400
1930	17700	1941	1400	1952	28500	1964	13100
1931	3580	1942	9760	1953	5820	1965	11500
1932	7870	1943	24000	1954	3770	1966	5080
1933	19200	1944	24400	1955	4540	1967	10200
1934	3770	1945	12400	1956	17600	1968	27400
1935	5080	1946	6970	1957	15900	1969	16400
1936	7290	1947	17200	1958	14900	1970	9500
1937	17100	1948	11700	1959	31400	1971	11200
1938	13400	1949	25400	1960	8340	1972	6240
1939	15400	1950	20000	1961	20300	1973	10300
				1962	9770		

Appendix B-3 (cont.).

Appendix C.

Low Flow Stream Characteristics.

03276000 East Fork Whitewater River at Brookville, Ind.

LOCATION.--Lat 39°26'02", long 85°00'12", in NE 1/4 NE 1/4 sec. 20, T. 9 N., R. 2 W., 100 ft upstream from bridge on State Highway 101, 1.4 miles northeast of Brookville, and 1.8 miles upstream from mouth.

DRAINAGE AREA.--380 sq mi.

DISCHARGE DATA AVAILABLE.--March 1954 to September 1967.

SELECTED DISCHARGE CHARACTERISTICS.--
Average discharge: 360 cfs (13 years)
Minimum daily discharge: 17 cfs September 1964
1-day, 30-year low flow: 17 cfs

Magnitude and frequency of annual low flow

Period (Consecutive days)	Discharge, in cfs, for indicated recurrence interval, in years				
	2	5	10	20	50
1	30	22	19	18	---
3	31	22	20	18	---
7	32	23	20	19	---
14	34	25	22	21	---
30	40	30	26	24	---
60	49	34	29	26	---

Magnitude and frequency of summer low flow

Period (Consecutive days)	Discharge, in cfs, for indicated recurrence interval, in years				
	2	5	10	20	50
1	37	30	28	27	---
3	38	31	30	29	---
7	42	33	31	31	---
14	45	37	36	35	---
30	54	41	39	38	---
60	95	66	60	58	---

Duration of daily flow for indicated period

Months	Period	Discharge, in cfs, which was exceeded for indicated percent of time during 1955-67 water years							
		98	95	90	80	70	50	20	10
3	Aug.-Oct.	22	26	30	35	39	54	100	150
6	May-Oct.	25	30	35	46	58	97	251	424
3	June-Aug.	34	38	45	56	67	103	234	404
12	Oct.-Sept.	28	34	41	56	75	150	420	750

Appendix C-1 (11).

03276500 Whitewater River at Brookville, Ind.

LOCATION.--Lat 39°24'24", long 85°00'46", in NW 1/4 sec. 32, T. 9 N., R. 2 W., at downstream side of highway bridge, 0.3 mile downstream from East Fork Whitewater River, and 1.1 miles south of Brookville.

DRAINAGE AREA.--1,224 sq mi.

DISCHARGE DATA AVAILABLE.--June 1915 to September 1917, July 1923 to September 1967.

SELECTED DISCHARGE CHARACTERISTICS.--
Average discharge: 1,244 cfs (46 years)
Minimum daily discharge: 60 cfs July 1934
1-day, 30-year low flow: 66 cfs

Magnitude and frequency of annual low flow

Period (Consecutive days)	Discharge, in cfs, for indicated recurrence interval, in years				
	2	5	10	20	50
1	126	92	79	71	62
3	130	95	82	73	65
7	136	100	86	77	69
14	143	105	91	82	73
30	160	116	100	90	81
60	192	133	112	98	86

Magnitude and frequency of summer low flow

Period (Consecutive days)	Discharge, in cfs, for indicated recurrence interval, in years				
	2	5	10	20	50
1	160	113	94	82	69
3	165	118	99	86	74
7	174	124	105	92	80
14	189	134	116	105	96
30	236	161	139	126	116
60	380	230	181	150	124

Duration of daily flow for indicated period

Months	Period	Discharge, in cfs, which was exceeded for indicated percent of time during 1917-67 water years							
		98	95	90	80	70	50	20	10
3	Aug.-Oct.	90	100	111	132	157	214	408	690
6	May-Oct.	95	109	129	168	216	344	880	1,510
3	June-Aug.	101	123	155	202	250	374	810	1,420
12	Oct.-Sept.	103	120	145	209	280	530	1,530	2,600

03275000 Whitewater River near Alpine, Ind.

LOCATION.--Lat 39°34'23", long 85°09'27", in sec. 14, T. 13 N., R. 12 E., Fayette County, 500 ft downstream from highway bridge, 0.4 mile downstream from Wilson Creek, 1.6 miles northeast of Alpine, and 4.7 miles upstream from Bear Creek.

DRAINAGE AREA.--529 sq mi.

DISCHARGE DATA AVAILABLE.--October 1928 to September 1967.

SELECTED DISCHARGE CHARACTERISTICS.--

Average discharge:	528 cfs (39 years)
Minimum daily discharge:	30 cfs August 1934
1-day, 30-year low flow:	34 cfs

Magnitude and frequency of annual low flow

Period (Consecutive days)	Discharge, in cfs, for indicated recurrence interval, in years				
	2	5	10	20	50
1	66	48	41	36	32
3	70	51	44	39	34
7	74	54	47	41	37
14	77	58	51	46	42
30	83	63	56	52	48
60	96	71	62	56	51

Magnitude and frequency of summer low flow

Period (Consecutive days)	Discharge, in cfs, for indicated recurrence interval, in years				
	2	5	10	20	50
1	83	56	46	38	32
3	88	60	50	42	35
7	93	64	53	45	38
14 *	102	70	59	50	42
30 *	124	81	66	55	44
60 *	176	110	87	70	56

Duration of daily flow for indicated period

Months	Period	Discharge, in cfs, which was exceeded for indicated percent of time during 1929-67 water years							
		98	95	90	80	70	50	20	10
3	Aug.-Oct.	45	53	61	71	80	104	182	282
6	May-Oct.	49	59	69	85	107	163	370	590
3	June-Aug.	52	65	80	102	126	180	352	545
12	Oct.-Sept.	54	64	77	100	127	233	625	1,080

*reconstructed curve

Appendix C-3 (11).

03275200 Salt Creek near Metamora, Ind.

LOCATION.--Lat 39°26'45", long 85°11'01", in SW 1/4 sec. 34, T. 12 N., R. 12 E., Franklin County, 0.3 mile south of U.S. Highway 52 and 2 3/4 miles west of Metamora.

DRAINAGE AREA.--115 sq mi.

DISCHARGE DATA AVAILABLE.--Low-flow measurements, 1954, 1960-67.

SELECTED DISCHARGE CHARACTERISTICS.--Minimum flow observed: 0.7 cfs November 1964
7-day, 2-year low flow: 1.0 cfs
7-day, 10-year low flow: .3 cfs
50% daily flow duration: 16 cfs
90% daily flow duration: 1.1 cfs

Appendix C-4 (11).

Appendix D.

Borehole Data.

APPENDIX D-1. Geotechnical Investigation US 52 Over Whitewater Canal (33).

Boring No.	Sample No.	Highway Route No.	Station No.	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description		Blow per Ft.	Recovery	RQD	Grain Size Distribution				LL	PL	PI	Notes
							Texture	AASHTO				Gravel	Sand	Silt	Clay				
1	1	U.S. 52	110+83	26L	685.5	0.0-0.5	Topsoil	-	-	-		-	-	-	-	-	-	-	-
1	2	over	"	"	"	0.5-2.5	Gravelly Sand	A-1-b	4	80%		-	-	-	-	-	-	-	-
1	3	Whitewater	"	"	"	2.5-5.5	Clay Loam	-	9	85%		-	-	-	-	-	-	-	-
1	4	Canal	"	"	"	5.5-9.5	Sandy Loam	A-4(o)	3	100%		1.9%	49.1%	35.5%	13.5%	22	12	5	6.0-7.5'
									17	100%		-	-	-	-	-	-	-	-
1	5	"	"	"	"	9.5-23.5	Gravelly Sand	A-1-b	24	25%		-	-	-	-	-	-	-	-
									15	55%		-	-	-	-	-	-	-	-
1	6	"	"	"	"	23.0-28.0	Sandy Gravel	A-1-a(o)	32	60%		69.1%	22.9%	8.0		NP	NP	NP	-
1	7	"	"	"	"	28.0-30.0	Gravelly Sand	A-1-b	34	95%		27.6	61.7	5.3		NP	NP	NP	-
2	1	"	111+36	26L	681.9	0.0-1.0	Topsoil	-	-	-		-	-	-	-	-	-	-	-
2	2	"	"	"	"	1.0-5.5	Silty Clay Loam	A-6(15)	2	15%		-	-	-	-	-	-	-	-
									7	100%		0.0	12.5	58.8	28.7	36	19	17	3.5-5.0'
2	3	"	"	"	"	5.5-8.0	Sandy Clay Loam	-	-	-		-	-	-	-	-	-	-	-
2	4	"	"	"	"	8.0-50.0	Gravelly Snad	A-1-b(o)	20	50%		-	-	-	-	-	-	-	-
									72	25%		-	-	-	-	-	-	-	-
									26	30%		-	-	-	-	-	-	-	-
									28	80%		37.0	56.4	6.6		NP	NP	NP	-
									25	50%		-	-	-	-	-	-	-	-
									33	70%		-	-	-	-	-	-	-	-
									25	50%		-	-	-	-	-	-	-	-
									37	80%		-	-	-	-	-	-	-	-
									48	85%		-	-	-	-	-	-	-	-
3	1	"	111+73	26R	688.1	0.0-1.0	Topsoil	-	-	-		-	-	-	-	-	-	-	-
3	2	"	"	"	"	1.0-3.0	Sand & Gravel	-	4	70%		-	-	-	-	-	-	-	-
3	3	"	"	"	"	3.0-8.0	Silty Clay Loam	A-6	5	100%		-	-	-	-	-	-	-	-
									7	100%		-	-	-	-	-	-	-	-
3	4	"	"	"	"	8.0-14.0	Silty Loam	A-4(o)	6	65%		0.1	40.0	50.1	9.8	22	19	3	-
									11	55%		-	-	-	-	-	-	-	-
3	5	"	"	"	"	14.0-40.0	Gravelly Sand	A-1-b	37	85%		-	-	-	-	-	-	-	-
									19	80%		-	-	-	-	-	-	-	-
									38	80%		-	-	-	-	-	-	-	-
									62	60%		-	-	-	-	-	-	-	-
									28	80%		-	-	-	-	-	-	-	-

APPENDIX D-2. Report of Roadway Soil Survey Brookville Access Road No. 1 (34).

Boring No.	Sample No.	Highway Route No.	Station No.	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description		Blow per Ft.	Recovery	RQD	Grain Size Distribution				LL	PL	PI	Notes
							Texture	AASHTO				Gravel	Sand	Silt	Clay				
4	1	Between	107+80	31L	1022.0	0.0- 1.3	Sandy Clay Loam	-	13	90%		-	-	-	-	-	-	-	-
4	2	Brookville	"	"	"	1.3- 5.5	Silty Clay	A-7-6(27)	16	90%		0.6	6.8	53.4	11.3	47.9	21.2	26.7	1.5-2.0'
4	3	Reservoir	"	"	"	5.5- 7.5	Clay Loam	A-4(2)	23	90%		10.7	32.7	32.8	9.6	22.5	14.2	8.3	6.0-7.5'
		and S.R. 1																	
5	1	"	125+00	8R	1015.0	0.0- 7.5	Clay Loam with Trace Gravel	A-4(2)	20	100%		5.2	33.5	37.1	9.0	23.1	14.8	8.3	1.0-2.5'
									18	100%									
									14	90%									
6	1	Between	194+00	8R	1001.0	0.0- 2.0	Clay	A-6(13)	14	35%		1.3	14.2	46.1	10.5	35.3	19.3	16.0	0.5-1.5'
6	2	Blooming	"	"	"	2.0- 5.5	Clay Loam	A-4	16	50%		-	-	-	-	-	-	-	-
6	3	Grove	"	"	"	5.5-12.0	Clay	A-6	6	60%		-	-	-	-	-	-	-	-
		and							4	70%		-	-	-	-	-	-	-	-
		Brookville							6	80%		-	-	-	-	-	-	-	-
6	4	Reservoir	"	"	"	12.0-15.0	Sand	-	42	100%		-	-	-	-	-	-	-	-
6	5	"	"	"	"	15.0-16.5	Clay Loam	A-4	42	100%		-	-	-	-	-	-	-	-
6	6	"	"	"	"	16.5-17.5	Sand	-	-	-		-	-	-	-	-	-	-	-
6	7	"	"	"	"	17.5-19.0	Clay	A-6(5)	43	100%		6.5	22.3	37.6	14.7	26.7	15.9	10.8	-

APPENDIX D-3. Soil Survey Investigation, Blue Creek Road Over Whitewater River (35).

Boring No.	Sample No.	Highway Route No.	Station No.	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description Texture	Soil Description AASHTO	Blow per Ft.	Recovery	RQD	Grain Size Distribution Gravel	Sand	Silt	Clay	LL	PL	PI	Notes
7	1	Blue Creek	16+50	45L	630.2	0.0- 0.2	Topsoil	-	-	-		-	-	-	-	-	-	-	-
7	2	Rd. over	"	"	"	0.2- 6.0	Silty Loam	A-4(0)	6	100%		1.7	25.9	56.1	16.3	NP	NP	NP	-
7	3	Whitewater	"	"	"	6.0- 8.0	Sandy Loam	A-4	7	75%		-	-	-	-	-	-	-	-
7	4	River	"	"	"	8.0-10.0	Sitly Loam	A-4	4	80%		-	-	-	-	-	-	-	-
8	1	"	28+17	3R	615.2	0.0- 0.2	Topsoil	-	-	-		-	-	-	-	-	-	-	-
8	2	"	"	"	"	0.2- 5.5	Silty Clay Loam	A-4(6)	7	78%		-	-	-	-	-	-	-	-
									6	89%		1.0	13.2	65.6	20.2	29	21	8	3.5-5.0'
8	3	"	"	"	"	5.5-11.5	Loam	A-4(0)	4	100%		0.0	38.4	47.1	14.5	24	20	4	6.0-7.5'
									3	78%		-	-	-	-	-	-	-	-
8	4	"	"	"	"	11.5-14.5	Sand	A-1-b	10	89%		-	-	-	-	-	-	-	-
8	5	"	"	"	"	14.5-20.0	Sandy Gravel	A-1-a	51	83%		-	-	-	-	-	-	-	-
9	1		19+85	18L	593.5	0.0- 8.5	Sandy Gravel	A-1-a	10	100%		-	-	-	-	-	-	-	River
									7	100%		-	-	-	-	-	-	-	Bottom
									22	100%		-	-	-	-	-	-	-	-
9	2	"	"	".	"	8.5-48.5	Gravelly Sand	A-2-4	30	87%		-	-	-	-	-	-	-	-
									12	100%		-	-	-	-	-	-	-	-
									33	80%		-	-	-	-	-	-	-	-
									38	56%		-	-	-	-	-	-	-	-
									37	50%		-	-	-	-	-	-	-	-
									44	100%		-	-	-	-	-	-	-	-
									42	61%		-	-	-	-	-	-	-	-
									43	100%		-	-	-	-	-	-	-	-
9	3	"	"	"	"	48.5-70.0	Sandy Gravel	A-1-a(0)	50	69%		-	-	-	-	-	-	-	-
									49	50%		-	-	-	-	-	-	-	-
									49	22%		-	-	-	-	-	-	-	-
									50	22%		53.3	42.7	4.0		NP	NP	NP	63.5-65'
									48	28%		-	-	-	-	-	-	-	-
10	1	"	20+67	18R	598.6	0.0- 9.5	Sandy Loam	A-4(0)	3	28%		-	-	-	-	-	-	-	Water At
									2	44%		0.1	63.9	26.2	9.8	NP	NP	NP	Surface
									6	100%		-	-	-	-	-	-	-	-
10	2	"	"	"	"	9.5-17.5	Sandy Gravel	A-1-a	51	50%		-	-	-	-	-	-	-	-
									27	56%		-	-	-	-	-	-	-	-
10	3	"	"	"	"	17.5-22.0	Sand	A-1-b	23	58%		-	-	-	-	-	-	-	-
11	1	"	25+08	18R	612.8	0.0- .04	Topsoil	-	-	-		-	-	-	-	-	-	-	-
11	2	"	"	"	"	0.4- 3.0	Sandy Load	A-4	9	100%		-	-	-	-	-	-	-	-
11	3	"	"	"	"	3.0-12.5	Silty Loam	A-4	5	56%		-	-	-	-	-	-	-	-
									4	78%		-	-	-	-	-	-	-	-
									4	61%		-	-	-	-	-	-	-	-
11	4	"	"	"	"	12.5-17.5	Gravelly Sand	A-2-4(0)	14	83%		24.1	57.5	18.4		NP	NP	NP	13.5-15'
11	5	"	"	"	"	17.5-22.0	Sandy Gravel	A-1-a	32	78%		-	-	-	-	-	-	-	-
11	6	"	"	"	"	22.0-26.0	Gravelly Sand	A-2-4	21	33%		-	-	-	-	-	-	-	-
11	7	"	"	"	"	26.0-30.0	Sandy Gravel	A-1-a	43	67%		-	-	-	-	-	-	-	-

APPENDIX D-3. Continued.

Boring No.	Sample No.	Highway Route No.	Station No.	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description		Blow per Ft.	Recovery	RQD	Grain Size Distribution				LL	PL	PI	Notes
							Texture	AASHTO				Gravel	Sand	Silt	Clay				
12	1	Blue Creek	25+80	18L	611.1	0.0- 0.2	Topsoil	-	-	-		-	-	-	-	-	-	-	-
12	2	Road over	"	"	"	0.2- 9.0	Sandy Loam	A-4(0)	7	94%		-	-	-	-	-	-	-	-
		Whitewater							4	94%		2.0	49.0	33.0	16.0	22	15	7	3.5-5'
		River							5	50%		-	-	-	-	-	-	-	-
12	3	"	"	"	"	9.0-12.0	Silty Loam	A-4	7	67%		-	-	-	-	-	-	-	-
12	4	"	"	"	"	12.0-16.0	Gravelly Sand	A-2-4	10	72%		-	-	-	-	-	-	-	-
12	5	"	"	"	"	16.0-22.0	Sandy Gravel	A-1-a(0)	55	100%		58.3	37.1	4.6		NP	NP	NP	18.5-20.0'
12	6	"	"	"	"	22.0-28.5	Gravelly Sand	A-1-b(0)	22	78%		31.2	60.7	8.1		NP	NP	NP	23.5-25'
12	7	"	"	"	"	28.5-35.0	Sand	A-1-b(0)	26	100%		0.7	94.7	4.6		NP	NP	NP	28.5-30'
									25	78%		-	-	-	-	-	-	-	-
13	1	"	25+79	18L	611.1	0.0-0.2	Topsoil	-	-	-		-	-	-	-	-	-	-	-
13	2	"	"	"	"	0.2-6.0	Sandy Loam	A-4(0)	-	100%		8.0	23.0	52.3	16.7	25	23	2	1.0-3.0'
									-	100%		-	-	-	-	-	-	-	-

APPENDIX D-4: Soil Survey Investigation along US 52 Approximately 10.1 miles South of SR 101 (28)

Boring No.	Sample No.	Highway Route No.	Station No.	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery	RQD	Grain Size Distribution: Gravel	Sand	Silt	Clay	LL	PL	PI	Notes
14	1	US 52	12+69	15L	579.9	0.0- 2.0	Fill	-	6	80%		-	-	-	-	-	-	-	-
14	2	Approx. 10.1 mi south of SR 101	"	"	"	2.0-21.5	Stiff Clay w/ rock fragments	A-7-6(7)	5	5%		-	-	-	-	-	-	-	-
									16	90%		-	-	-	-	-	-	-	-
									12	30%		-	-	-	-	-	-	-	-
									13	90%		-	-	-	-	-	-	-	-
									23	90%		-	-	-	-	-	-	-	-
									27	90%		-	-	-	-	-	-	-	-
									26	90%		-	-	-	-	-	-	-	-
									24	100%		-	-	-	-	-	-	-	-
14	3	"	"	"	"	21.5-23.5	Silty clay w/ trace gravel	A-4(7)	24	100%		-	-	-	-	-	-	-	-
14	4	"	"	"	"	23.5-28.5	Clay w/limestone layers	A-7-6	36	50%		-	-	-	-	-	-	-	-
									51	80%		-	-	-	-	-	-	-	-

APPENDIX D-5: Soil Survey Investigation for Landslide Correction US 52 Approximately 2.8 Miles West of SR 46 (29)

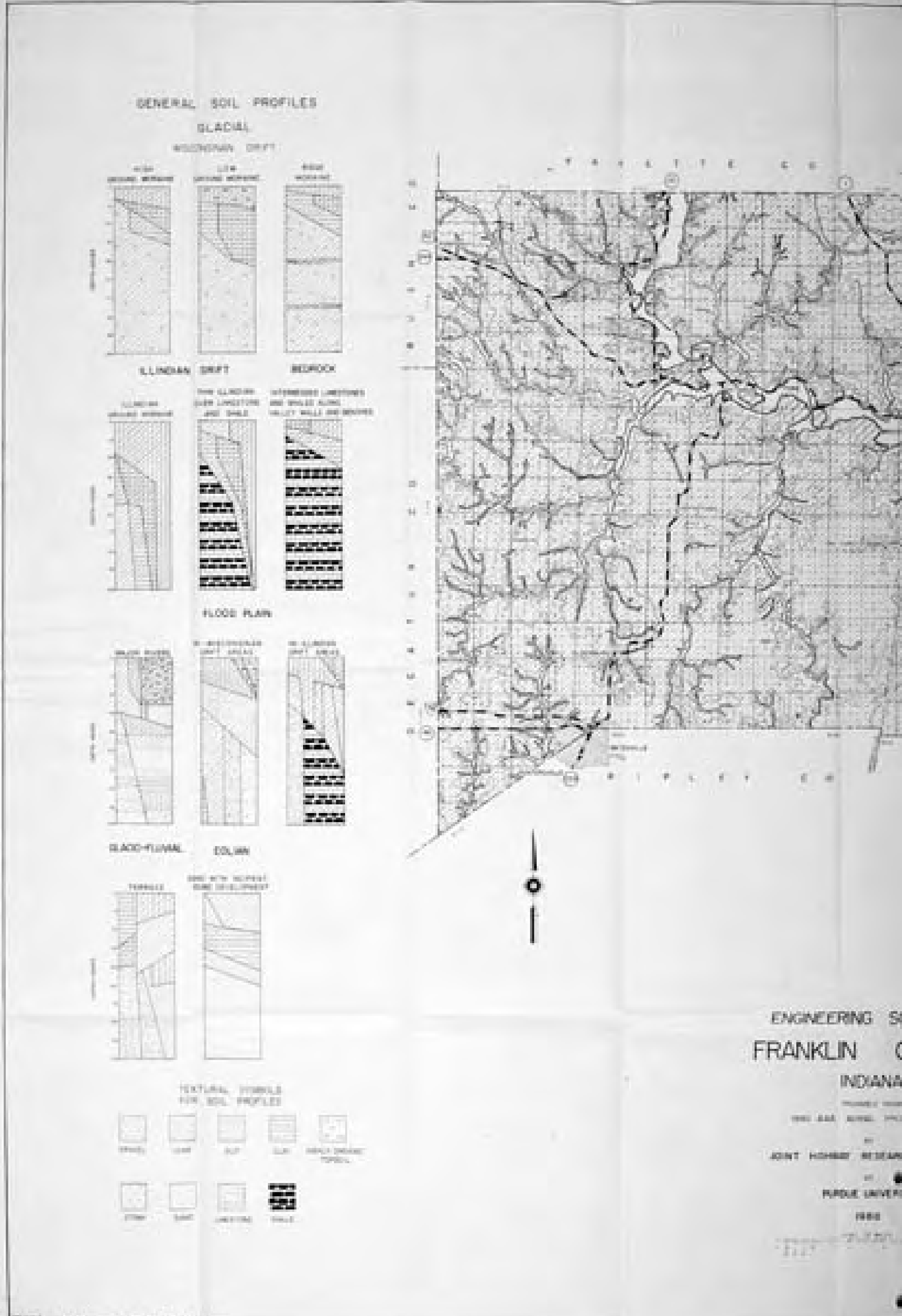
Boring No.	Sample No.	Highway Route No.	Station No.	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery	RQD	Grain Size Distribution: Gravel	Sand	Silt	Clay	LL	PL	PI	Notes
15	1	US 52 near	527+17	15R	552.8	0.0- 5.0	Medium stiff clay	A-7-5	10	50%		-	-	-	-	-	-	-	-
									6	40%		-	-	-	-	-	-	-	-
15	2	SR 46	"	"	"	6.0-23.3	Hard clay w/ limestone frag-ments	A-7-6(22)	10	100%		7.1	10.6	39.7	42.6	48.9	23.4	25.5	-
									51	60%		-	-	-	-	-	-	-	-
15	3	"	"	"	"	23.3-27.0	Clay w/limestone fragments	A-6	26	30%		-	-	-	-	-	-	-	-
15	4	"	"	"	"	27.0-33.8	Interbedded lime-stone & shale	-	-	100%		-	-	-	-	-	-	-	-
16	1	"	535+33	13R	555.2	0.0- 2.0	Sandy loam	-	12	40%		-	-	-	-	-	-	-	-
16	2	"	"	"	"	2.0- 8.0	Clay w/limestone fragments	A-7-6	16	100%		-	-	-	-	-	-	-	-
16	3	"	"	"	"	8.0-31.0	Stiff clay with limestone frag-ments	-	14	100%		-	-	-	-	-	-	-	-

APPENDIX D-6: Report of Geotechnical Investigation, SR 252 over East Fork Whitewater River (36)

Boring No.	Sample No.	Highway Route No.	Station No.	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery	RQD	Grain Size Distribution: Gravel	Sand	Silt	Clay	LL	PL	PI	Notes
17	1	SR 252	57+15	30L	627.0	0.0- 4.5	Fill	-	-	-		-	-	-	-	-	-	-	-
17	2	over	"	"	"	4.5- 7.5	Sandy loam	A-1-6(0)	4	-		10	64	- 26 -		-	-	-	-
		East Fork							5	-		-	-	-	-	-	-	-	-
17	3	Whitewater	"	"	"	7.5-10.0	Sandy loam	A-1-6	13	-		-	-	-	-	-	-	-	-
17	4	River	"	"	"	10.0-20.0	Sandy gravel	A-1-a	16	-		-	-	-	-	-	-	-	-
									27	-		-	-	-	-	-	-	-	-
18	1	"	57+85	20R	613.5	0.0- 1.0	Sandy loam fill	A-1-6	13	-		-	-	-	-	-	-	-	-
18	2	"	"	"	"	1.0- 2.5	Clay loam	A-6	16	-		-	-	-	-	-	-	-	-
18	3	"	"	"	"	2.5- 5.0	Clay loam	A-6(4)	3	-		30	17	30	23	32.7	18.6	14.1	-
18	4	"	"	"	"	5.0- 7.5	Sandy loam	A-1-a	17	-		-	-	-	-	-	-	-	-
									18	-		-	-	-	-	-	-	-	-
18	5	"	"	"	"	7.5-10.0	Sandy gravel	A-1-a(1)	16	-		54	40	- 6 -		-	-	-	-

APPENDIX D-7: Subsurface Investigation for SR 252 over Little Cedar Creek (37)

Boring No.	Sample No.	Highway Route No.	Station No.	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery	RQD	Grain Size Distribution: Gravel	Sand	Silt	Clay	LL	PL	PI	Notes
19	1	SR 252	561+91	20L	714.0	0.0- 0.4	Topsoil	-	-	-		-	-	-	-	-	-	-	-
19	2	over	"	"	"	0.4- 3.0	Silty loam	A-4(1)	14	80%		9	24	51	16	27	23	24	-
19	3	Little Cedar	"	"	"	3.0- 8.5	Clay loam w/ rock fragments	A-4	67	80%		-	-	-	-	-	-	-	-
19	4	Creek	"	"	"	8.5-12.0	Sandy loam w/ gravel												
20	1	"	563+03	20R	715.8	0.0- 9.0	Clay loam	A-4(1)	2	0%		-	-	-	-	-	-	-	-
									6	70%		-	-	-	-	-	-	-	-
									9	80%		6	44	30	20	23	14	9	6.0-7.5'
									12	100%		-	-	-	-	-	-	-	-
20	2	"	"	"	"	9.0-12.0	Clay loam	A-4	12	100%		-	-	-	-	-	-	-	-
20	3	"	"	"	"	12.0-30.0	Clay loam	A-4(1)	45	100%		-	-	-	-	-	-	-	-
									21	100%		-	-	-	-	-	-	-	-
									27	100%		5	32	41	22	20	14	6	23.5-25.0'
									27	80%		-	-	-	-	-	-	-	-


GENERAL SOIL PROFILES
GLACIAL
WISCONSINAN DRIFT
ILLINOIAN DRIFT
BEDROCK
FLOOD PLAIN
GLACIO-FLUVIAL
EOLIAN
TEXTURAL SYMBOLS
FOR SOIL PROFILES
ENGINEERING
FRANKLIN
INDIANA

ENGINEERING SOILS MAP
FRANKLIN COUNTY
INDIANA

JOINT HIGHWAY RESEARCH PROJECT

PURDUE UNIVERSITY